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KERNEL BLITZ '95 Interactive Training Support (KBITS) **Technical Integration Plan**

T. R. Tiernan P. A. Swanson A. A. Ketteringham C. J. Poulos

Naval Command, Control and
Ocean Surveillance Center
RDT&E Division

San Diego, CA
92152-5001

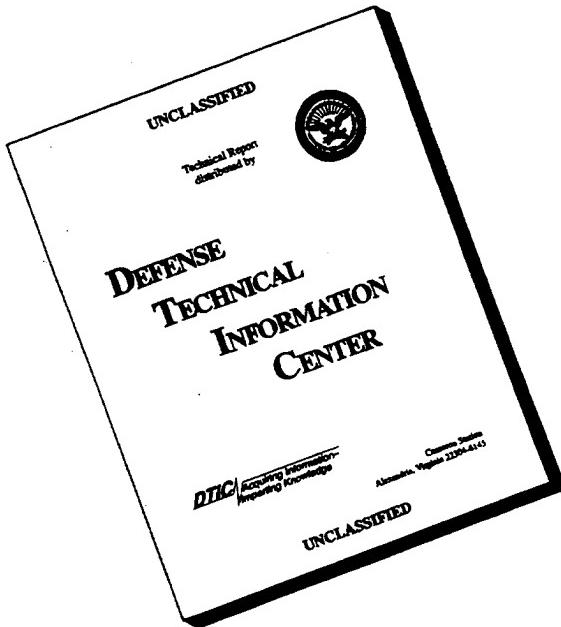
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Interactive Training
Support (KBITS)**

Technical Integration Plan

T. R. Tiernan
P. A. Swanson
A. A. Ketteringham
C. J. Poulos

**NAVAL COMMAND, CONTROL AND
OCEAN SURVEILLANCE CENTER
RDT&E DIVISION
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ADMINISTRATIVE INFORMATION

The work described in this document was carried out by personnel from the Naval Command, Control and Ocean Surveillance Center RDT&E Division (NRaD). Sponsorship was provided by the Advanced Research Projects Agency.

Released under authority of
J. D. Grossman, Head
Simulation and Human Systems Technology Division

EXECUTIVE SUMMARY

KERNEL BLITZ '95 (KB 95) was conducted 3-6 April 1995. The Navy had over 23 ships, numerous aircraft, and 12,000 personnel at sea for this exercise. Simulation participants included five Defense Simulation Internet (DSI) node sites and three backside sites. In this exercise, live units and simulation systems were successfully integrated into a Synthetic Theater of War (STOW). The objective of KB 95 was to improve the ability of Naval Expeditionary Forces to operate effectively, as a total force, in a joint, littoral environment.

KERNEL BLITZ Interactive Training Support (KBITS), the simulation portion of the exercise, provided a simulated carrier battle group (CVBG), geo-transformation of Surface Mine Counter Measure (SMCM) forces operating in the Gulf of Mexico, and air, land, and sea opposing forces (OPFOR). KBITS' objective was to enable naval forces to train in a realistic force structure, demonstrate the capability to enrich training by combining afloat and ashore training activities, and provide the infrastructure to more realistically train in a joint, littoral environment.

Simulations were provided by the following: Naval Sea Systems Command (NAVSEA) Battle Force Tactical Training (BFTT) Program; Advanced Research Projects Agency (ARPA) Semi-Automated Forces (SAF) Program Modular Semi-Automated Forces (ModSAF); Naval Undersea Warfare Center (NUWC) Combined Team Trainer Mode (CTTM) Program; Naval Air Warfare Center - Aircraft Division (NAWC-AD) Air Combat Environment Test and Evaluation Facility (ACETEF) E-2C simulator; and Program Engineering Office Mine In Shore Warfare (PEO MIW/SPAWAR-32) MCM C⁴I Joint Maritime Command Information System (JIMCIS) Program. The BFTT-TACDEW (Tactical Advanced Combat Direction and Electronic Warfare) interface was used to integrate Distributed Interactive Simulation (DIS) based simulation with the Fleet Combat Training Center, Pacific (FCTCPAC) TACDEW system. Inherent TACDEW capability processed simulation data into Link-11 and Officer in Tactical Command Information Exchange System (OTCIXS) Rainform Gold Formats for transmission to live and simulated forces for C² functions by players.

KBITS testing began 1 February 1995 and included DSI connectivity checks, a Sub-System Integration Test (SSIT), three System Integration Tests (SITs), a Global Positioning System (GPS) Time Server Test, Functional Validation (FV), Network Checks, a Dress Rehearsal, and a Final System Checkout on 29 March 1995.

Comments from the training audience, which ranged from navy flag officers to petty officers, were extremely positive. The sponsors congratulated all who took part in "introducing to the Navy what may very well be the way we train in the future." NRaD's contributions, ranging from technical integration and hardware/software support, to integration testing and technical control during KB 95 were extremely successful. Initial evaluation shows that all KBITS objectives were successfully met.

CONTENTS

EXECUTIVE SUMMARY	i
1. INTRODUCTION	1
1.1 BACKGROUND	1
1.2 CONCEPT AND OBJECTIVES DEVELOPMENT	1
1.3 CONCEPT AND TECHNOLOGY DEVELOPMENT PROCESS	3
1.4 SCOPE	6
2. INTEGRATION MANAGEMENT	8
2.1 APPROACH	8
2.2 RISKS	8
2.3 COORDINATION	8
2.4 DEPLOYMENT PLANNING	8
3. SIMULATION REQUIREMENTS	8
3.1 SIMULATION GENERATION	8
3.2 SIMULATION NETWORK	9
3.3 TACTICAL DATA SUPPORT	11
3.4 TACTICAL COMMUNICATIONS SUPPORT	11
4. INTEGRATION TESTING	12
4.1 TEST PROCESS	12
4.2 INTEGRATION TEST PLAN	12
4.3 PROBLEM REPORTS	14
4.4 LOGS AND REPORTS	14
4.5 FINAL REPORT	14
4.6 DS1 AVAILABILITY SUMMARY	14
4.7 TESTING	15
5. KERNEL BLITZ 1995	16
5.1 DS1 RADIO	17
5.2 DATA COLLECTION AND ANALYSIS	17
5.2.1 Data Logging	17
5.2.2 Bandwidth Analysis	17
5.2.3 Data Rate Collection	19
5.3 C ⁴ I	19
5.3.1 Link-11/OTCIXS	19
5.3.2 SMCM	19
5.4 DS1	21
5.5 SITE COMMENTS	21

Appendices

A: ACRONYMS	A-1
B: KBITS DIS 2.0.3+	B-1
C: KBITS SITE TOPOLOGIES	C-1

Figures

1. KB 95 simulation requirements overview	2
2. DIS simulation fidelity	4
3. Fidelity continuum	4
4. Fidelity relationships	5
5. KBITS core simulations/simulators	7

Tables

1. KBITS site summary	10
2. KBITS test schedule	13
3. DSI summary	14
4. Bandwidth estimates for each site prior to KB 95	18
5. KBITS transmission data rates	20

1. INTRODUCTION

1.1 BACKGROUND

KERNEL BLITZ '95 (KB 95) was a Commander in Chief, U.S. Pacific Fleet (CINCPACFLT) directed training exercise of live Amphibious Task Force (ATF) and Amphibious Readiness Group (ARG) ships and personnel, with embarked Marine Expeditionary Unit (MEU) forces, in a Marine Expeditionary Force (MEF) size amphibious assault exercise. Commander, Third Fleet (COMTHIRDFLT) was the Officer Scheduling Exercise (OSE), and Commander, Amphibious Group Three (COMPHIBGRU THREE) was the Officer Conducting Exercise (OCE). Additional live supporting forces of the Navy, Marine Corps, and Coast Guard also participated. In this exercise, the live units and simulation systems were integrated into a Synthetic Theater of War (STOW). The simulation portion of the exercise, known as KERNEL BLITZ Interactive Training Support (KBITS), provided a simulated carrier battle group (CVBG), performing a blocking force support mission, geo-transformation of Surface Mine Counter Measure (SMCM) forces, and opposing forces (OPFOR). All simulated forces were "tactically visible" to the live forces at sea. These simulations were provided through integration of Distributed Interactive Simulation (DIS) technology simulations located across the country, existing C⁴I systems, and existing Navy Tactical Advanced Combat Direction and Electronic Warfare (TACDEW) and Mod TACDEW simulation systems at Fleet Combat Training Center, Pacific (FCTCPAC), linked together over the Defense Simulation Internet (DSI). This included DIS-compliant simulators, such as aircraft, ships, missiles, and other weapons systems, working together to portray a more realistic exercise. Additionally, a scenario control voice network was also carried over the DSI network using "virtual radios."

The Advanced Research Projects Agency (ARPA) is the STOW Program Sponsor. N6, as the Office of the Chief of Naval Operations (OPNAV) sponsor for KB 95 simulation support, provided funding for development, integration, and execution of KBITS. Naval Doctrine Command (NDC) was the KBITS Simulation Coordinator, functioning as the Navy point of contact (POC) for ARPA and the Defense Modeling and Simulation Office (DMSO), and coordinating KBITS activities with CINCPACFLT, COMTHIRDFLT, and COMPHIBGRU THREE. NDC also defined end-user requirements and acted as principal advisor to COMTHIRDFLT in developing the KB 95 scenario within simulation capabilities. SPAWAR-30 provided advisory and funding support to NDC and acted as point of contact for integration of SMCM C⁴I. The Naval Command, Control and Ocean Surveillance Center (NCCOSC) Research, Development, Test and Evaluation (RDT&E) Division (NRaD) was the KBITS Technical Integrator.

1.2 CONCEPT AND OBJECTIVES DEVELOPMENT

The simulation concept for KB 95 was requirements based. Amphibious Group Three (CPG-3) required enhanced operational and tactical environments to train effectively. There was not a Aircraft Carrier Battle Group (CVBG) available to train with the ATF live forces. An ATF would not reasonably be employed without the protection offered by at least one CVBG in a supporting role. The KB 95 training scenario dictated, at minimum, a force structure of one CVBG in support of the ATF. Additionally, Navy resources to provide live OPFOR from operational forces are extremely limited, and live support is often nil due to this extreme limitation. The concept of simulating the forces not available to train with the live forces evolved from the above.

The stated objective as provided by the OCE CPG-3 was as follows:

Create in simulation, a CVBG to provide battlespace dominance around and over the ATF during approach to the landing area and during the landing effort. The simulation will support the CWC, AAW, ASUW, and ASW missions and attempt to influence the OTC's decision making ability in conduct of the landing mission. In addition, create a believable OPFOR through simulation to support the exercise scenario. The simulation will be "TACTICALLY VISIBLE" to the live afloat forces and real time. Under the auspices of the simulation management, integrate the C⁴I transformation of SMCM assets from the GOMEX to the SOCAL OPAREA.

Figure 1 gives an overview of the simulation requirements.

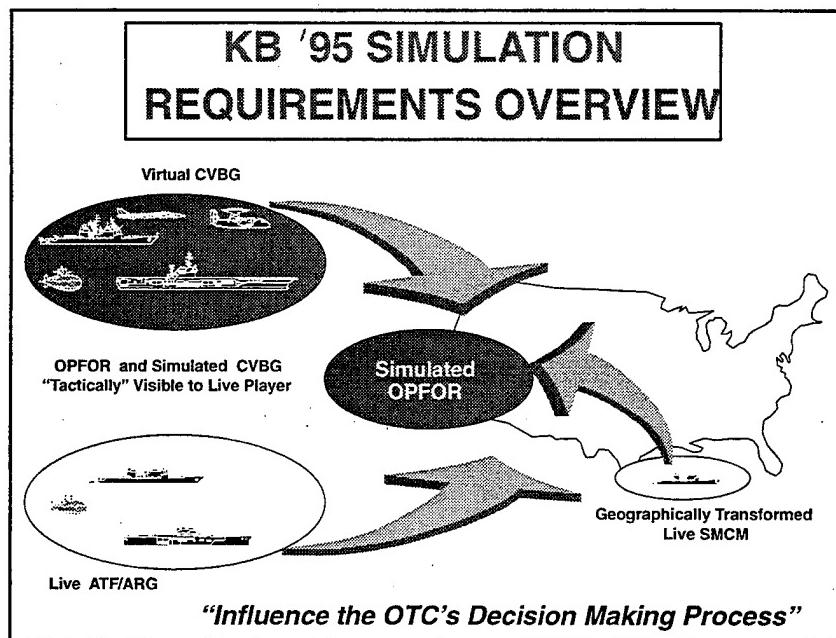


Figure 1. KB 95 simulation requirements overview.

NDC agreed that the concept and objective were viable. To gain the maximum benefit from the investment, NDC decided to take the effort several steps farther and, in doing so, enhance the primary objective. The first consideration was to make the CVBG simulation more believable to the afloat OTC by providing realistic behaviors. The desire of this effort was to ensure that when the OTC afloat interfaced with the simulation, whether through Link-11, Officer in Tactical Command Information Exchange System (OTCIXS), voice, or message, it would be believable and would possess the correct behaviors. This could best be accomplished by employing an actual CVBG Commander and warfare commanders to provide the command and control to the simulated forces and provide the interface between the OTC and the simulation using the same C⁴I displays available to the afloat OTC. To accomplish this, the scenario was designed to support a Tactical Training Group BFTT-type event, integrating, for the first time, afloat and ashore training events of the Navy Training Strategy. Secondly, if successful, this concept could offer a single, flexible, modern technology architecture for both Tactical Training Group (TACTRAGRU) and Fleet Combat Trainer Center (FCTC) simulation training support. This architecture holds the potential to reduce total life cycle costs of two present systems, update both systems with modern simulation technology, provide an accepted architecture for joint interoperability of simulations with other services, and reduce the

number of personnel required to both operate and maintain the simulation suites at the TACTRA-GRUs and FCTCs. Finally, NDC planned to leave as much of the architecture in place so that the West Coast training managers could employ this same technology in the future at a greatly reduced cost to Navy Tier I and Joint Tier II and III exercises.

The additional NDC objectives were:

1. Allow Naval Forces (ATF/ARG) to train in a realistic force structure package through simulation (with CVBG), opposed by a realistic OPFOR
2. Demonstrate capability to enrich training by combining afloat and ashore training activities
 - Demonstrate potential costs savings
 - Demonstrate MCM concept
3. Demonstrate potential replacement for the Enhanced Navy Wargaming System (ENWGS) and Mod TACDEW
4. Provide infrastructure to more realistically train in a joint, littoral environment through simulation

1.3 CONCEPT AND TECHNOLOGY DEVELOPMENT PROCESS

NDC was in the process of systematically examining the STOW-E technical demonstration to determine the potential of DIS in tactical and operational training when CPG-3 requested assistance from the Navy Modeling and Simulation Office. The requirements to support KB 95 were wrapped into the questions NDC would address. Issues of fidelity at several levels of the C² continuum and C⁴I interfaces were of principal interest.

The goal of simulation in military tactical training is to elicit the same behaviors from the training audience that would be exhibited in actual combat execution. This is accomplished by stimulating the training audience with simulation with a degree of fidelity that is recognized by the audience as representative of an actual tactical or operational environment. In terms of DIS and tactical training, NDC used three primary references for determination of fidelity of a tactical environment.¹ Figure 2 shows a graphical representation of DIS simulation fidelity. The first reference is the degree of portrayal qualities of the tactical environment. The second is representation of the tactical environment in terms of correct numbers of entities or platforms. The third is the correct representation of tactical behaviors of those entities. The efficient employment of simulation would dictate that investment matches the degree of fidelity necessary to stimulate and elicit proper behaviors and no more.

NDC used STOW-E to investigate the above premise. In STOW-E, simulated tactical training environments were developed, using a multitude of different simulations of varying fidelities and of various constructive live and virtual simulations. As one would expect, the closer a participant is associated with performing an actual tactic, the more behaviorally complex the environment must become to elicit proper responses. For example, a pilot at the controls of an F-14 simulation interfacing tactically with a MIG-29 demands the behavior of the MIG-29 to be much more robust or

1. This concept of defining DIS fidelity was first presented in a white paper conceived and written by CDR Dennis McBride while a program manager at ARPA. In the paper, CDR McBride defined DIS fidelity on a relative basis between simulations. With apologies to CDR McBride, this concept has been applied to simulation environments in definition of overall fidelity environments.

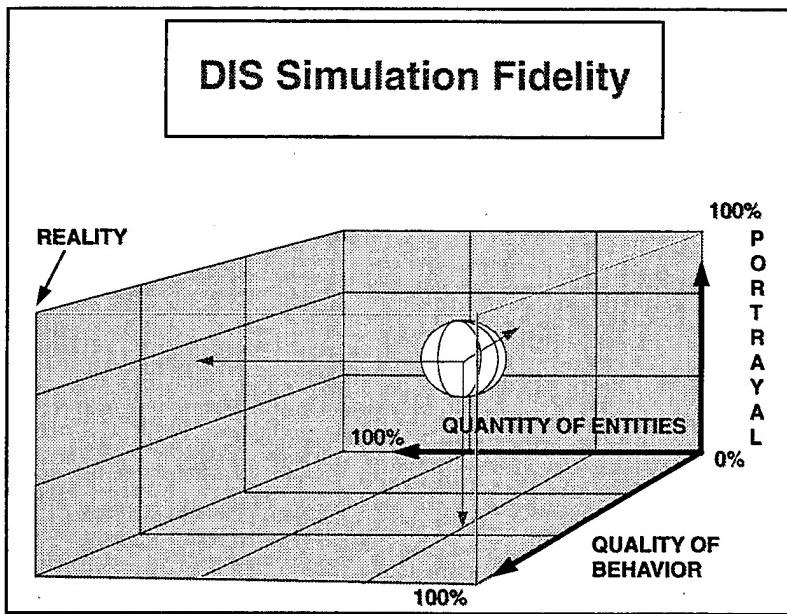


Figure 2. DIS simulation fidelity.

complex than the Anti-Air Warfare Commander demands of either simulation. The warfare commander needs the simulation behavior of the two to reflect that an engagement is actually taking place and that a proper behavioral result occurs. The F-14 pilot requires the MIG-29 simulation to behave in a much more complex fashion, exhibiting all the behaviors expected from a MIG-29, from pilot responsiveness to aircraft performance characteristics. Figure 3 shows this relationship in an arbitrary manner through a C² continuum. Through this demonstration, NDC determined Computer Generated Forces (CGF) were suitable for several target training audiences throughout the C² hierarchy from the CVBG Commander to unit-level console operators.

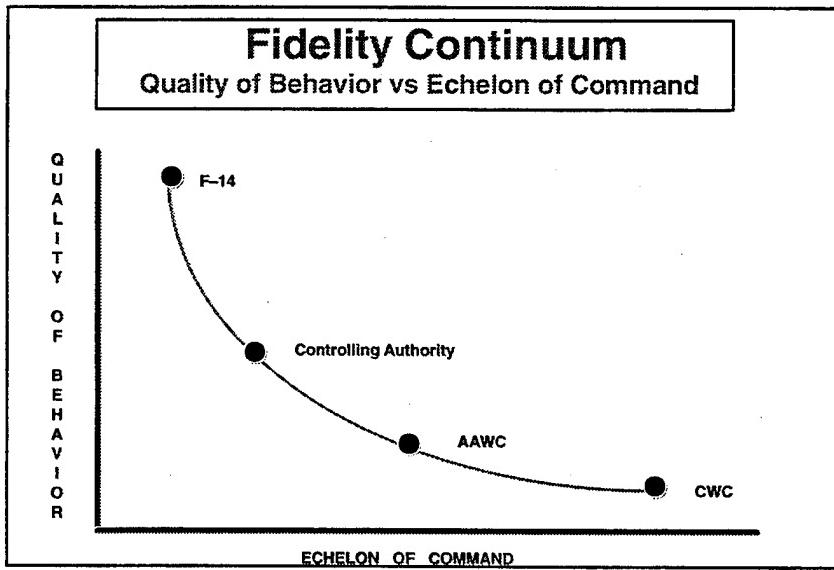


Figure 3. Fidelity continuum.

The portrayal and quantity of entities presented in the STOW-E demonstration pointed to additional differences in the needs of participants in terms of DIS fidelity. Where the pilot in an F-14 simulator requires high-resolution portrayal capabilities in terms of visual out-the-window queues

and sensor interfaces, the warfare commander or CVBG commander requires very-low-resolution portrayal characteristics of interface. On the other hand, an F-14 would generally never interface with more than 10 to 15 other entities or platforms at a given time. A warfare commander, however, needs visibility across an expansive geographical volume of the battlespace, encompassing a very high number of entities, visibility he would normally be privy to through C⁴I systems.

Figure 4 reflects the differences in DIS fidelity demands between two extremes of the C² continuum. The F-14 man-in-the-loop simulation would require fidelity with the simulation environment at the upper right-hand area of the graph, while the warfare commander's needs would rest in the bottom left-hand corner of the graph.

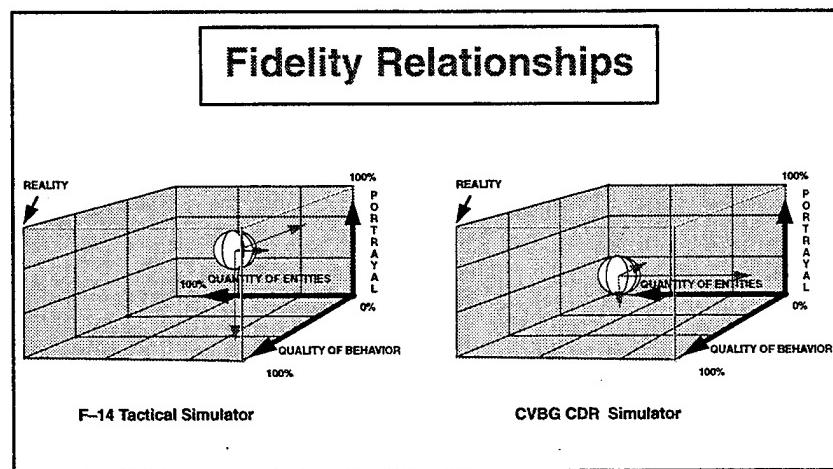


Figure 4. Fidelity relationships.

Throughout the STOW-E test and execution period, NDC found that CGF, specifically the Loral/ARPA ModSAF² and BFTT Battle Force Operational Console (BOPC),³ were able to transcend the entire C² continuum from the unit console operator, through F-14 man-in-the-loop simulation, to warfare commander and CVBG Commander, and provide believable behavioral representations. CGF have the added benefit of being very low cost. CGF also require very few operators to control many battlespace entities due to their knowledge-based behavior libraries. CGF are extremely flexible in their ability to control entities in real time, and require little to no pre-exercise database loads as do current constructive simulations such as the Aggregate Level Simulation Protocols (ALSP) Confederations. It does require a Terrain Data Base (TDB) in the Compact Terrain Database Format, which must be considered with adequate lead time to produce.

Given a credible simulation engine to drive the KB 95 simulation, correct portrayal characteristics were necessary to provide accurate interface to the target training audience for KB 95. The primary portrayal device used by warfare commanders and above in the Navy rests in C⁴I systems. The

-
- 2. ModSAF was originally developed by Loral for the USA to provide OPFOR to SIMNET armored forces. It was adapted to the air environment by ARPA to facilitate development of Intelligent Forces in the WISSARD Lab at NAS Oceana.
 - 3. BFTT BOPC is a SAF-like device developed by the BFTT program. Its state of maturity is low as its current design functionality was developed only in sufficient capability to provide scenario generation capability for the BFTT DT-IIA proof-of-concept demonstration. Talks between ARPA and the BFTT Program Office are underway to adopt the technology of the ModSAF capabilities into the BOPC.

battlespace is reflected to the decision makers using Naval Tactical Data Symbology on Joint Maritime Command Information Systems (JMCIS) displays. The principal feeds to JMCIS for basic platform position information are Link-11 (TADIL A) and OTCIXS data. Again, to elicit proper responses from the training audience, the correct stimulus must be applied. Warfare commanders are stimulated via C⁴I systems, not 2D or 3D graphics displays from simulation. The ability to drive real-time C⁴I systems with a behaviorally correct DIS simulation engine would provide the correct portrayal characteristics needed. It would have the added benefit of allowing integration of live players on real C⁴I systems into the game play and partially solve the DSI connectivity problem of seaward-bound participants.

Based on the requirements of KB 95, NDC decided to integrate Link-11 into STOW-E to provide insight into the simulation C⁴I integration problem. Because most Navy legacy simulators are derived from actual tactical equipment, digital Link-11 outputs are present. Using Logicon commercial off-the-shelf (COTS) Link-11 Distribution Systems over 9.6-kb voice quality telephone lines, a real Link-11 network was emulated. This not only allows simulations to interface with one another on a real tactical C⁴I system, but also allows this network to interface with C⁴I systems on live platforms. This concept was proven during STOW-E with several simulations and the *USS Hue City* (CG 66).

The integration of C⁴I proved its worth in a second way: during periods that the DSI network failed at certain simulation nodes, participants were able to keep up with the scenario and interact to the extent their role would allow through C⁴I connectivity. It also answered the question of whether all participants need to actually be on the simulation network itself. If the participant is in a command and control role, then he needs to be presented only with the C⁴I information and not the simulation information/data.

The results of STOW-E technical testing and demonstration indicated effective training environments could be produced by CGF and integrated into real tactical C⁴I systems. The concept baseline called for a target training audience from the OTC to the warfare commander level. Stimulation of the training audience would be facilitated primarily through CGFs. Full integration of C⁴I Link-11 and OTCIXS allowing for real-time manipulation of C⁴I data would be required as they are the primary warfighting interfaces of the training audience.

STOW-E provided the answers needed to conduct live afloat and real-time ashore training as an integrated process.

1.4 SCOPE

Simulations were provided by the following: Naval Sea Systems Command (NAVSEA) Battle Force Tactical Training (BFTT) Program; ARPA Semi-Automated Forces (SAF) Program Modular Semi-Automated Forces (ModSAF); Naval Undersea Warfare Center (NUWC) Combined Team Trainer Mode (CTTM) Program; Naval Air Warfare Center - Aircraft Division (NAWC-AD) Air Combat Environment Test and Evaluation Facility (ACETEF) E-2C simulator; and Program Engineering Office Mine In Shore Warfare (PEO MIW/SPAWAR-32) MCM C4I Joint Maritime Command Information System (JMCIS) Program. The BFTT-TACDEW interface was used to integrate DIS-based simulation with the FCTCPAC TACDEW system. Inherent TACDEW capability processed simulation data into Link-11 and OTCIXS Rainform Gold Formats for transmission to live and simulated forces for C² functions by players. Locations of KBITS simulations are shown in figure 5.

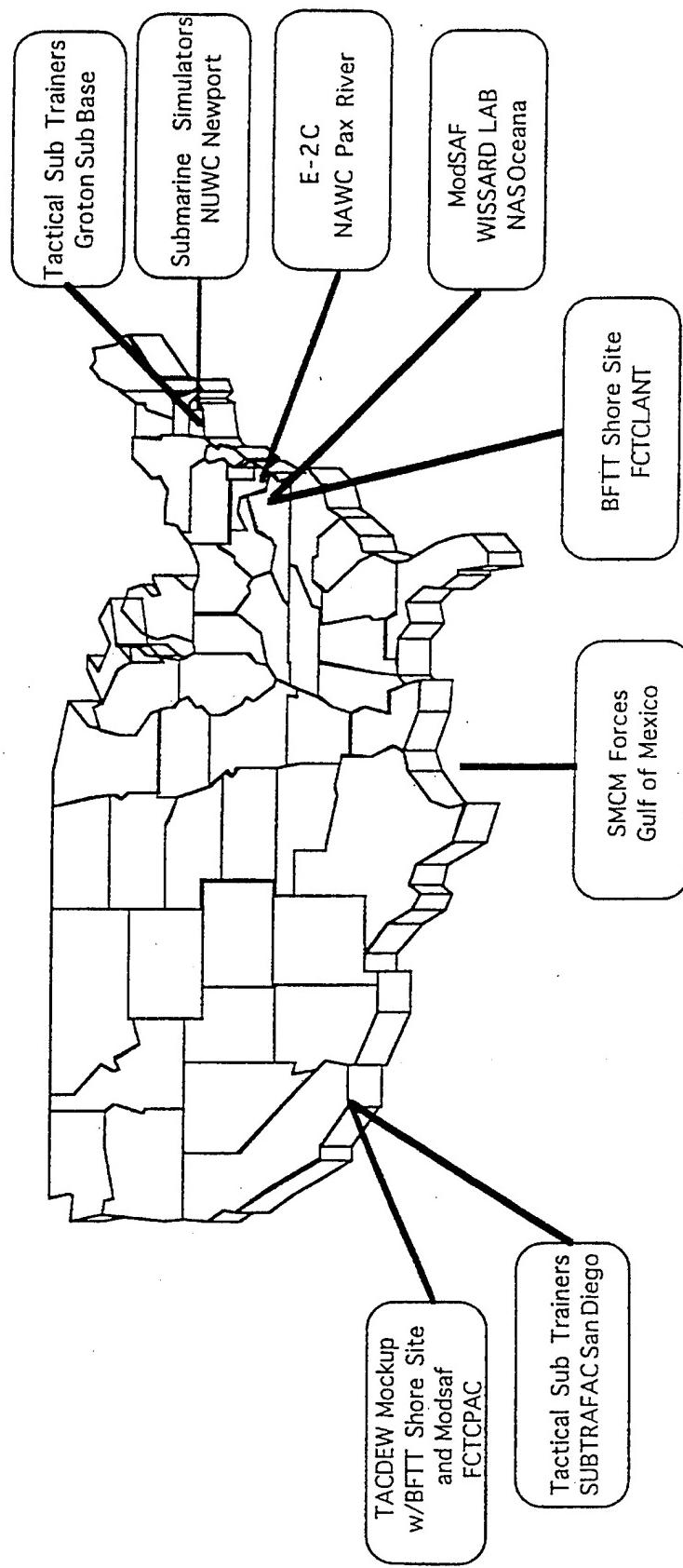


Figure 5. KBITs core simulations/simulators.

2. INTEGRATION MANAGEMENT

2.1 APPROACH

Integration management began in early January 1995, focusing people, data, procedures, software, and hardware necessary to successfully integrate the individual sites and systems into KBITS. The primary tool used was a database of KBITS System Integration Requirements for each site. Implementation guidance was contained in the KBITS Technical Integration Plan.

2.2 RISKS

The overall risk of KBITS was partially mitigated by the fact that four of the primary simulation sites participating (NUWC, NAWC-AD, FCTCLANT and WISSARD) had successfully demonstrated their capabilities during the recent STOW-E exercise. Risk was further reduced by limiting the number of new sites involved to the absolute minimum. Risk mitigation factors also included aggressive local site and subsystem integration testing, a Problem Report system, hardware and software that were off-the-shelf wherever possible, and the requirement that all simulation systems communicate via the IEEE Standard 1278 *Distributed Interactive Simulation Protocol Data Unit*, Version 2.0.3.

2.3 COORDINATION

A KBITS Simulation Working Group, chaired by NDC, was chartered to provide the infrastructure necessary to conduct KBITS planning, integration, and testing. As the Technical Integration Manager, NRaD was tasked with ensuring all site integration tasks were completed and database items collected. NRaD responsibilities included site liaison, site surveys, documentation, planning, security, hardware, and testing.

2.4 DEPLOYMENT PLANNING

Installations of equipment, systems, and networks at selected sites were temporary. Temporary installations consisted of secure hardware connectivity between NRaD and FCTCPAC, additional workstations at FCTCPAC to support ModSAF, a Multiple Unit Tactical Training System (MUTTS) system at San Clemente Island, leased data lines between DSI sites and their backside sites, data logging equipment at viewports, and GPS time servers. Equipment temporarily installed at the various sites was returned to the originating site(s) for upgrading, maintenance, storage, reuse in other projects or programs, or disposition as directed by the funding sponsor.

3. SIMULATION REQUIREMENTS

3.1 SIMULATION GENERATION

Blue assets included a CVBG, E-2C assets, and submarines. Opposition forces included air, surface, subsurface, and land-based forces. Simulated Blue Surface Mine Counter Measure (SMCM) forces were represented over C⁴I through a geo-transformation of live SMCM units operating in the Gulf of Mexico. Table 1 lists the KBITS sites, their simulation assignments, and points of contact. Details included:

1. Constructive simulation with a BFTT Shore Site Installation using TAC-III consoles, and constructive simulation with Modular Semi-Automated Forces (ModSAF) simulators, at FCTCPAC, San Diego, CA. BFTT program was responsible for providing the principal surface simulations for Blue Forces and OPFOR, and the DIS interface to Mod TACDEW in the BFTT Phase 1 upgrade to FCTCPAC. Mod TACDEW shadowed DIS inputted entities and produced Link-11 and OTCIXS output for transmission and input to at-sea units. BFTT shore site consoles installed at FCTCPAC provided Composite Warfare Coordinator (CWC) cell support to react to CWC orders and operations. BFTT shore site consoles installed at Fleet Combat Training Center, Atlantic (FCTCLANT) provided surface OPFOR.
2. Virtual simulation with the E-2C simulator at Naval Air Warfare Center - Aircraft Division (NAWC-AD), NAS Patuxent River, MD. NAWC-AD was responsible for realistic C⁴I output via the Simulated Warfare Environment Generator (SWEG) generated E-2C simulation.
3. Virtual simulation with the Submarine School Trainer (SST), Groton, CT, and the Submarine Training Facility (SUBTRAFAC), San Diego, CA, through backside connections to the Naval Undersea Warfare Center (NUWC), Newport, RI. Harpoon, Submarine Launched Mines, and Tomahawk flyout models were supported by NUWC labs, while all other functionality (sonar, MK-48, ADCAP, periscopes) was supported at the submarine simulators.
4. Constructive simulation with the ModSAF simulators at the "What If" Simulation System for Advanced Research & Development (WISSARD), NAS Oceana, VA. WISSARD was responsible for ModSAF air simulations for Blue Forces generated at FCTCPAC, and OPFOR air generated at WISSARD.
5. Live instrumentation and geo-transformations that effectively provided SMCM ships operating in the Gulf of Mexico (GOMEX) OPAREA, USS *Dextrous* (MCM 13) and USS *Scout* (MCM 08), with the MCM picture from the SOCAL OPAREA, and provided both the GOMEX area mine picture and a geographically transliterated mine picture to the Camp Pendleton OPAREA. FCTCPAC provided connectivity for the SMCM portion of KBITS.
6. Enumerations for KBITS were defined to support the simulated forces described in both Blue and Orange Schedules of Events (SOE). While most of these enumerations had been previously defined in DIS Protocol, version 2.0.3, a few had to be defined uniquely for KB 95. Appendix B lists the entities anticipated to be used in KBITS. It includes enumerations previously assigned by DIS 2.0.3, plus new ones added for KBITS, which are identified by double borders. This enhanced listing of enumerations is referred to as DIS 2.0.3+. In addition, some enumerations were assigned to real or live entities that could be reported both on Link-11, and used in a simulation. These enumerations are identified in words where they occur.

3.2 SIMULATION NETWORK

The Defense Simulation Internet (DSI) played a major role in supporting the communications requirements for KB 95, providing wide area network (WAN) connectivity between five DSI nodes. During KB 95, DSI network management and control functions were performed from the Network Control Center at the DSI Customer Service Center (CSC) in Leavenworth, KS. Leased lines (T-1 and 56 KB) provided connectivity between two DSI nodes and their three backside sites. While DSI is equipped to simultaneously handle voice, data, and image, during KB 95 it handled only simulation data and one scenario control voice circuit. Audio teleconference calls using Defense Switched Network (DSN) bridges were used to provide technical control of the DSI Network.

Table 1. KBITS site summary

SITE NAME	SITE ID	Simulation Assignment	DSI Capability	DSI Compliance	POC Management	POC Technical
NAWC-AD (PAX RIVER)	38	Blue E-2C OPFOR Ground (SWEG)	Full DSI	YES	Dan Macone (301)826-6009 (DSN 326) dmacona@tecn1.jctb.jcs.mil	Bob Ruddy (301)826-6014 ruddyb@seid.nawcad.navy.mil
NWMC (NEWPORT)	163	OPFOR Subs	Full DSI	YES	Gerald Santos (401)841-3434 (DSN 948) (401)841-1710 gsantos@dmso.dtic.dla.mil	Gerald Santos (401)841-3434 (DSN 948) (401)841-1710 gsantos@dmso.dtic.dla.mil
MISSARD (NAS OCEANA)	46	OPFOR AIR (Navy AirSAF)	Full DSI	YES	Ed Harvey (804)433-3091 (804) 433-3090	John McGinn (804)433-3091 (804) 433-3090
FCTCLANT (DAM NECK)	10	OPFOR Surface BFTT	Full DSI	YES	LTR ROB BURCH (804)433-8147 (804)433-8018	LT ROB BURCH (804)433-8147 (804)433-8018
FCTCPAC (SAN DIEGO)	185	Blue CVBG (BFTT) Blue Air (Navy AirSAF) Exercise Control	Backside to NFaD	YES	LCDR Bane (619)553-8104 (619)553-8473 bane@nosc.mil	LCDR Bane (619)553-8104 (619)553-8473 bane@nosc.mil
COMINWARCOM (CORPUS CHRISTI)	N/A	Blue MCM (Live)	Backside to FCTCPAC	N/A	Joe Mattingly (512)939-4859 (512)939-4898 cmwco2r@nosc.mil	Joe Mattingly (512)939-4859 (512)939-4898 cmwco2r@nosc.mil
NRaD (SAN DIEGO)	11	Technical Control and Datalogger	Full DSI	N/A	Paul Swanson (619)553-3569 (DSN 553) pswanson@nosc.mil	Chris Poulos (619)553-6149 (DSN 553) (619)553-1169 poulos@nosc.mil
SUBTRAFAC (SAN DIEGO)	163	Blue Sub	Backside to NUWC	YES	Lt. Matt Suess (619)553-0418 (619)553-7236 stf-snd.102@nlnmsa.netnavy.mil	Gerald Santos (401)841-3434 (DSN 948) (401)841-1710 gsantos@dmso.dtic.dla.mil
SUB SCHOOL (GROTON)	163	Blue Sub	Backside to NUWC	YES	Gerald Santos (401)841-3434 (DSN 948) (401)841-1710 gsantos@dmso.dtic.dla.mil	Gerald Santos (401)841-3434 (DSN 948) (401)841-1710 gsantos@dmso.dtic.dla.mil
APL VIEWPORT (LAUREL)	56	Viewport, Datalogger	Full DSI	N/A	Scott Osborne (301)953-6916 (301)953-5910 scott_osborne@jhupapl.edu	Robert Evans (301)953-6000 (301)953-5910 rbevans@apicom.jhuapl.edu

1. NRaD, as Technical Integration Manager, was responsible for integration and testing of simulations, associated simulation communications, net management, and simulation voice communications integration. During KB 95, NRaD was Technical Control and data logged the exercise.
2. Monitoring and data logging the exercise over DSI was accomplished by the Johns Hopkins University Applied Physics Laboratory (APL) Warfare Analysis Laboratory (WAL) Viewport, Laurel, MD.
3. FCTCPAC interfaced with DSI as a T-1 backside to NRaD.
4. NUWC was responsible for preparation and DSI connectivity of two 56-KB backsides: SUB-TRAFAC, San Diego and Submarine School, Groton.
5. BFTT program was responsible for providing the DIS interface to Mod TACDEW in the BFTT Phase 1 upgrade at FCTCPAC.
6. Greenwich Mean Time (GMT) was used throughout the exercise. During KBITS, all sites had GPS time servers attached to their LAN, and Network Time Protocol (NTP) software installed on a host work station. This combination provided timing accuracy of approximately 10 milliseconds.
7. Site topologies were submitted by each site before being allowed to join the KBITS network. Details included simulator layout, types of equipment, software installed, and connectivity. Site topologies are contained in appendix C.
8. Bandwidth requirements were calculated for each site. These bandwidth estimates were based on the type and number of entities and update frequency anticipated to support the Blue and Orange schedule of events (SOEs).

3.3 TACTICAL DATA SUPPORT

Existing C⁴I tactical data architecture was used to display simulation data to live exercise participants operating in the SOCAL OPAREA, and at FCTCPAC. UHF Link-11 tactical data was generated by the E-2C simulator, the submarine simulators, and by the BFTT Baseline 0 installation at FCTCPAC. Logicon equipment was used to connect UHF Link-11 between simulators. UHF Link-11 was transmitted from FCTCPAC via microwave to the MUTTS van on San Clemente Island, and transceived via UHF to live forces at sea. OTCIXS data were generated by the BFTT installation at FCTCPAC and by the SMCM forces in the Gulf of Mexico. This was transmitted to the live forces in the SOCAL OPAREA through the Pacific support satellite. OTCIXS data were also transmitted from FCTCPAC to APL; SUBTRAFAc, San Diego; Sub School, Groton; and NUWC over secure telephone lines.

3.4 TACTICAL COMMUNICATIONS SUPPORT

1. FCTCPAC, as the central simulation facility for support for KB 95, received both DIS and C⁴I information, merging the information into a single tactical display. FCTCPAC also provided UHF tactical voice, Mod TACDEW, OTCIXS, and Link-11 to live fleet units through MUTTS.
2. Virtual radios were used to establish a tactical communications network for OPFOR. These virtual radios functionally operated as push-to-talk (PTT), half-duplex radios sets. Virtual radios are electronic, computer-controlled equipment that digitize analog voice and send it over the DSI network. They used the DIS 2.0.3 specification for transmitter and signal protocol data units (PDUs). Two types of radios were used. One was a unit built by TSI, and

previously used by Warbreaker, and the other was a unit used by the BFTT simulations, built by NAWC-TSD in Orlando, FL. Both units would interoperate when some software changes, related to the voice encoding method, were made in the BFTT units.

The TSI radio uses the 8-bit MuLaw analog encoding method and creates a digital rate of nominally 64 KBPS. It is a PTT device and tunable to “pseudo” frequencies in the range of 0 to 999 MHz. It is also multichannel, having up to 10 channels. These channels can be preset and the transmitter can be moved from channel to channel. One can receive on up to 10 channels at a time, but will only receive the channel that is broadcasting at the moment. This is much akin to a very fast scanner. It has squelch and volume controls. There is a speaker out and microphone in connection. A hand terminal allows for configuring the radio to various ports, exercise IDs, “heartbeat” rate, and time. There are other settings reserved for future use.

The NAWC radio is a single fixed-frequency device that is also set to a specific UDP port and exercise ID. These are parameters set into the software. It uses a different encoding method than the TSI units, which is 16 Kbps.

4. INTEGRATION TESTING

4.1 TEST PROCESS

KBITS testing began on 1 February with 2 days of DSI connectivity checks, and ended with a Final System Checkout on 29 March. Between these dates, efforts included Sub-System Integration Test (SSIT), three System Integration Tests (SITs), a GPS Time Server Test, Functional Validation (FV), Network Checks, and Dress Rehearsal.

This step-by-step series testing facilitated the scheduling control necessary to accommodate introduction of additional sites and systems, as shown in table 2, in a timed sequence throughout the KBITS testing period, as well as allowing such efforts as equipment procurement and security resolutions to be spread out and balanced against available resources. DSI digital radio testing was conducted during several test phases as additional equipment became available. Individual site testing resolved emergent issues documented in Problem Reports, unique backdoor connectivity, addition of new sites, changes or additions in entities, connectivity methods, and KBITS network interface hardware and software modifications. Technical control of all testing was through a DSN conference call linking all test sites.

4.2 INTEGRATION TEST PLAN

A single Integration Test Plan was written that incorporated test objectives designed to support KBITS. Addendums were published that contained test procedures for individual test phases as needed. This approach was used because during STOW-E it became extremely difficult to write new test plans, distribute them in time to allow for review and comment, incorporate those comments, and redistribute to all sites before the test was executed. Results of each test phase were used in planning the procedures for subsequent test phases.

Table 2. KBITS test schedule.

SITE NAME	DSI Connectivity 1-2 Feb	SSIT 7-9 Feb	SIT 22-23 Feb	SIT A 1-2 Mar	GPS Time Server Test 9-Mar	SIT B 10-Mar	FV 15-16 Mar	Network Checks 21-Mar	Dress Rehearsal 22-23 Mar	Final System Checkout 29-Mar	Kernel Blitz 2-6 Apr
NAWC-AD (PAX RIVER)	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
NJMC (NEWPORT)	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
MISSARD (NAS OCEANA)	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
FCTCLANT (DAM NECK)	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
FCTCPAC (SAN DIEGO)						✓	✓	✓	✓	✓	✓
COMINWARCOM (CORPUS CHRISTI)						✓	✓	✓	✓	✓	✓
NRaD (SAN DIEGO)	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
SUBTRAFAC (SAN DIEGO)						✓	16-Mar		✓	✓	✓
SUB SCHOOL (Groton)									✓		✓
APL VIEWPORT (LAUREL)	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓

4.3 PROBLEM REPORTS

A Problem Report (PR) process was incorporated into the test effort. Any site or individual could submit a PR using a form provided in the Integration Test Plan. PRs were submitted to NRaD, where they were entered on a database to track resolution progress.

4.4 LOGS AND REPORTS

All participating sites were required to maintain Daily Test Activity Logs. These logs contained as much detail as practical for the log keeper. At the end of each testing day, NRaD compiled a Daily Report. A Weekly Update provided a synopsis of all testing that week.

4.5 FINAL REPORT

NRaD directed KBITS testing from 1 February through 29 March 1995. The purpose of KBITS testing was to prepare simulation sites for participation in the KB 95 exercise. A brief synopsis of each test period is given in paragraph 4.7 below.

4.6 DSI AVAILABILITY SUMMARY

Table 3 shows the number of DSI hours scheduled, number of DSI scheduled hours that were available, number of hours the DSI was actually used (including time made available by CSC before or after scheduled time), and percentage of scheduled time that was available.

Table 3. DSI summary.

		Hours Sched	Hours Avail	Hours Used	Percent Avail
DSI Connectivity	1 Feb	4.0	0.0	0.0	00.0
	2 Feb	4.0	1.5	1.5	37.8
SSIT	7 Feb	4.0	3.5	3.5	87.5
	8 Feb	4.0	4.0	4.3	100
	9 Feb	4.0	4.0	4.7	100
SIT	22 Feb	4.0	3.8	4.5	95.5
	23 Feb	4.0	3.9	7.0	99.6
SIT-A	1 Mar	4.0	4.0	5.5	100
	2 Mar	4.0	3.9	5.7	97.2
GPS Time Server	9 Mar	3.5	3.5	3.5	100
SIT-B	10 Mar	4.0	4.0	5.8	100
FV	15 Mar	4.0	4.0	5.5	100
	16 Mar	4.0	4.0	7.5	100
Network Checks	21 Mar	2.0	2.0	2.0	100
Dress Rehearsal	22 Mar	4.0	3.9	5.7	98.0
	23 Mar	4.0	3.3	7.5	83.3
Final System Check	24 Mar	4.0	3.6	4.8	90.4
TOTALS		65.5	59.07	79.0	90.2

4.7 TESTING

1. DSI Connectivity (1-2 FEB): CSC was unable to bring up the DSI on 1 February. On 2 February NRaD, WISSARD, NAWC-AD, and FCTCLANT were networked with entities exchanged. NUWC could not participate because they had not received their INES software from CSC. Testing procedures were re-established based on STOW-E experiences. DSI radios were tested with mixed results.
2. SSIT (7-9 FEB): This event was designed to test interactions of DIS protocol entities generated by the simulation sites. Entities were generated by NUWC, NAWC-AD, FCTCLANT, and WISSARD. APL participated as a Viewport. Testing was controlled from NRaD. A successful digital voice communications test was conducted between NRaD and NAWC-AD.
3. SIT (22-23 FEB): This event was designed to test simulation interactions of four DSI node sites (NUWC, NAWC-AD, FCTCLANT, and WISSARD), and three backside sites (FCTCPAC through NRaD, and SUBTRAFAC and Submarine School through NUWC). APL participated as a Viewport. NRaD controlled the test. Most of the test period was taken up attempting to isolate simulation system problems at individual sites. No test objectives were accomplished the first day, and only a few were completed the second day.
4. SIT-A (1-2 MAR): This event was scheduled as a repeat of SIT, with the same sites participating (except Submarine School), the same test procedures, and the same objectives. SIT-A was much more successful than SIT. Connectivity problems between NRaD and FCTCPAC were solved over the previous weekend, enabling FCTCPAC to join the group for the first time. This was considered critical as FCTCPAC was to be the conduit between the simulation world and the KB 95 exercise. Most site software problems from the previous week had also been corrected. Additional DSI time (outside of the scheduled time) was made available for testing because CSC completed stream setup early both days. Most of the test objectives were completed over the 2-day test period. Additional DSI Radio tests were successfully completed between FCTCPAC, NRaD, FCTCLANT and NAWC-AD.
5. GPS Time Servers (9 MAR): This was a special test of GPS Time Servers and Network Time Protocol (NTP) software. Only NRaD, FCTCPAC, WISSARD, and NAWC-AD were involved. All sites reported good results. Times were within 1-2 seconds of each other.
6. SIT-B (10 MAR): This event continued testing of DSI sites (NUWC, NAWC-AD, FCTCLANT, and WISSARD), and two backside sites (FCTCPAC through the NRaD, and SUBTRAFAC through NUWC). APL participated as a Viewport. SIT-B objectives included testing of GPS Time Servers and associated software, continued testing of DSI radio equipment, and load testing the FCTCPAC TACDEW system. A fourth objective, testing a new Terrain Data Base (TDB), could not be accomplished because the software, developed by the Topographic Engineering Center (TEC), was not available for testing.
7. FV (15-16 MAR): Functional Validation participants included all DSI sites (NUWC, NAWC-AD, FCTCLANT, and WISSARD), and two backside sites (FCTCPAC through the NRaD, and SUBTRAFAC through NUWC). APL was a Viewport. FV objectives included testing GPS Time Servers, DSI radio equipment, Entity Validations, Weapons Interactions, load testing the FCTCPAC TACDEW system, and C⁴I Communications. An additional objective, testing a new TDB could not be accomplished because the software was not available. Most objectives were successfully accomplished. End-to-end C⁴I communications could not be demonstrated because some of the equipment was not ready or in place.

8. Network Checks (21 MAR): Participants included all DSI sites (NUWC, NAWC-AD, FCTCLANT, and WISSARD), and one backside site (FCTCPAC through the NRaD). APL was a Viewport. All local GPS Time Servers provided accurate times. All sites also had accurate times at remote workstations except NAWC-AD and NUWC. DSI radio testing went well except for a newly discovered interoperability problem with BFTT radios being unable to receive and decode virtual (DSI) radio transmissions.
9. Dress Rehearsal (22-23 MAR): Participants included all DSI sites (NUWC, NAWC-AD, FCTCLANT, and WISSARD), and three backside sites (FCTCPAC through NRaD, and SUBTRAFAc and Submarine School through NUWC). APL was a Viewport. Dress Rehearsal objectives were similar to FV, with the addition of a run through of all Kernel Blitz Schedule of Events (SOE) simulation events. Most objectives were successfully accomplished. Naval Doctrine Command characterized Dress Rehearsal as "2 days of rigorous and excellent testing....We accomplished bringing all simulation to the table as planned and translating the same into C⁴I."
10. Final System Check (29 MAR): Participants included all DSI sites (NUWC, NAWC-AD, FCTCLANT, and WISSARD), and two backside sites (FCTCPAC through NRaD, and SUBTRAFAc through NUWC). APL was a Viewport. Testing included a repeat of the Dress Rehearsal SOE Day 22 events.

5. KERNEL BLITZ 1995

KB 95 was conducted 3-6 April 1995. The Navy had over 23 ships, numerous aircraft, and 12,000 personnel at sea for this exercise. Simulation participants included five DSI node sites: NUWC, NAWC-AD, FCTCLANT, WISSARD, and NRaD, and three backside sites: FCTCPAC, SUBTRAFAc, and Submarine School Groton. APL was a Viewport. Simulation highlights included:

- Simulation of a carrier battle group (CVBG), and all air, surface, subsurface, and land-based opposing forces. There over 450 simulated air sorties and over 90 simulated surface sorties conducted.
- Integration of C⁴I and Distributed Interactive Simulation (DIS) systems.
- Development of Surface Mine Counter Measure (SMCM) C⁴I geo-transformation capability.
- Demonstrated integration of at-sea with ashore training.
- Acceleration of Battle Force Tactical Trainer (BFTT) integration to the fleet.
- Integration of Digital Voice communications from DSI to UHF.
- Demonstration of a Modular Weapons Server.

Comments from the training audience, which ranged from navy flag officers to petty officers, were extremely positive. The sponsors congratulated all who took part in "introducing to the Navy what may very well be the way we train in the future," and a "super job by all; stand by for more of the same endeavors." NRaD's contributions, ranging from technical integration and hardware/software support, to integration testing and technical control during KB 95 were extremely successful. Initial evaluation shows that all KBITS objectives were successfully attained.

5.1 DSI RADIO

During the simulation activities of Kernel Blitz, virtual radios were used to control the Opposing Forces (OPFOR). These virtual radios functionally operated as PTT, half-duplex radios sets.

The virtual radios were connected to the Expanded Voice Communications System (EVCS) audio (digital) patching system at FCTCPAC, from the audio side. This allowed anyone connected into this system to be able to communicate over the DSI network. The receive side of the DSI radios were connected to VOX (Voice Activated) keyers that would key transmitters upon receipt of audio voice. Operators were able to communicate from the FCTCPAC ModSAF positions through the EVCS, and out over the DSI network. There were UHF radios connected into the EVCS via microwave to San Clemente Island as well as local radios which were tested from the DSI radios. During the exercise it was decided NOT to have the USS *Coronado* (AGF 11) and USS *Peleliu* (LHA 5) "on line" with the DSI radio network."

The units worked well during the exercise and, other than a couple of occasions where there were some garbled communications, the operation was satisfactory. The major factor in the proper operation was the allocation of sufficient bandwidth for the radios. Any time latency or "jitter" in the delivery of PDUs will cause loss of communications and/or garbled communications. In as much as the radios occupy the same data space as the simulation traffic, this traffic will impinge upon the proper operation of the radios. The use of these radios has a distinct advantage over other non-DSI methods as to quality and availability. The other methods depend primarily on switched analog systems that are susceptible to preemption and poor voice quality. The major disadvantage of the virtual radios is the bandwidth requirements.

The major future effort that should be undertaken is to use another voice encoding method to eliminate the excessive bandwidth requirement. These virtual radios could be used on multiple nets to simulate Tactical Voice nets. The flexibility of the TSI units to switch rapidly between preset frequencies and the ability to guard frequencies are valuable for simulating tactical voice networks in a simulated environment.

5.2 DATA COLLECTION AND ANALYSIS

5.2.1 Data Logging

KB 95 DIS traffic was data logged at NRaD and APL for archival purposes. There is currently no plan for analysis of these data.

5.2.2 Bandwidth Analysis

During testing phases prior to KB 95, bandwidth estimates were made for each site exchanging digital data on DSI. These estimates were derived from the kind of entities, number of entities, and update frequency anticipated in supporting the Blue and OPFOR SOEs. Allotted bandwidths also include 70 Kbits per second for DSI radios.

Equations used and bandwidth estimations are shown in table 4. They give bandwidth as a function of the number of entities, articulated parts, average rate of usage, and size of header, and are expressed in Kbits per second. It should be noted that these bandwidth calculations were based on an average distribution of entity transmissions. However, in actual usage, these transmissions were not sent on an average distribution but sent in bursts of approximately 0.5 second, as empirically

Table 4. Bandwidth estimates for each site prior to KB 95.

Bandwidth Estimates										
Entity	1	2	3	4	5	NUWC BW=(144B)/16s+ 16(Parts)*50 NAWC ModSAT at WISARD x (Avg Rate) x (No. Entities), Kbits per sec	NUWC BW=(144B)/16s+ 16(Parts)*50 NAWC x (Avg Rate) FAX RIVER x (8) x (No. Entities), Kbits per sec	FCTCPAC BW=((144B)/16s+ 16(Parts)*50) BTTF x (Avg Rate) SD x (No. Entities), Kbits per sec	Avg PDU's = (.6 x Low + 2 x High), per Second	Total Entity BW _s (9.16*16(Parts)*50) (Rate Bytes/sec) (8B/8s*50) Anticollad. PDU's
Number Entities	Kbits per sec	Number Entities	Kbits per sec	Number Entities	Kbits per sec	Number Entities	Kbits per sec	Number Entities	Kbits per sec	Total Entity BW _s (9.16*16(Parts)*50) (Rate Bytes/sec) (8B/8s*50) Anticollad. PDU's
Submarine	0	0	0	7	17	5	12	40	1	0.6
Ship	28	69	0	4	36	152	0	62	1	2
FWA	0	26	113	1	0	0	0	7	2	1.2
RWA	0	7	22	0	0	0	0	7	2	4
SSNs (SCUDs)	1	9	0	1	9	1	9	4	5	2.8
AAMs	0	4	37	0	10	93	0	14	5	0
SAMs	4	37	0	0	4	37	0	5	10	0
Air/Ground Ms.	0	2	19	0	0	0	0	2	5	0
Mines	0	0	0	0	0	0	0	0	0	0
Torpedoes	0	4	4	0	0	0	0	3	3	0.5
Acoustic PDUs @ 40 Bytes each	0	0	0	0	0	0	0	11	2	0.224
Air/Ground Bombs	0	10	9	0	0	0	0	10	0.5	0
Estimated Number of Entities per Site:	33	53	2	57	116	261	2			TOTAL Estimated BW
Estimated Bandwidth per Site, Kbits/sec	116	204	14	309	60					708
Allocated Bandwidth: (Kbits/sec) / (Packets/sec) 3/21/95	164 / 23	280 / 35	96 / 12	344 / 43	184 / 23					1088 / 136

determined from the visual display provided by the Network Visualization (NETVIS). To accommodate the bandwidth for these bursts, the allotment for NUWC had to be increased, and the planned use of 90 mines was reduced to 39 mines.

5.2.3 Data Rate Collection

NETVIS, connected via the NRaD Local Area Network (LAN), was used to monitor real-time data rates on DSI. This display could be interpreted as an approximation of number of packets sent by each site on the DSI Wide Area Network (WAN). This was done by having NETVIS display the number of bytes within a time interval of 0.05 second divided by 1000 bytes per packet, based on the fact that T/20 routers at each site “bundled” approximately 1000 bytes of data into each packet. A DSI packet could have less than 1000 bytes of data if it took longer than 0.2 second to fill its output buffer, or if the bundling of the LAN packets did not exactly equal 1000 bytes.

This approximation is on the low side of the actual packet rate. However, considering the likelihood of “time outs,” assuming near full output buffers, and the inaccuracy in reading the display, these approximations are probably within 20 percent of the actual WAN packet rates.

During testing prior to KB 95, the bandwidth used by TSI virtual radios at FCTCPAC was monitored at 88 Kbits per second (11 packets per second), and the bandwidth used by BFTT virtual radios at FCTCLANT was monitored at 44 Kbits per second. No data were observed on NETVIS from either of these radios during KB 95. They may not have been observed because of infrequent and unannounced use.

Results of bandwidth data collected during KB 95 is shown in table 5. Bandwidths allocated were adequate for the number of entities used.

5.3 C⁴I

5.3.1 Link-11/OTCIXS

1. FCTCPAC, as the central simulation facility for support to KB 95, and as a backside to NRaD, received both DIS and C⁴I information, merging them into a single tactical display. FCTCPAC also hosted Commander, Cruiser Destroyer Group 3 (COMCRUDESGRU THREE) and staff during KB 95, and provided UHF tactical voice, OTCIXS, and Link-11 to live fleet units through MUTTS. FCTCPAC also provided connectivity for the SMCM portion of KBITS. Mod TACDEW, at FCTCPAC, shadowed DIS-inputted entities and produced Link-11 and OTCIXS output for transmission and input to at-sea units.
2. NUWC provided connectivity to SUBTRAFAC and Submarine School at Groton, and integration of OTCIXS and Link-11 data into all submarine simulation sites.
3. NAWC-AD provided realistic C⁴I output from the SWEG-generated E-2C simulation. Link-11 output was also be produced by SWEG and transmitted over voice-quality telecommunications lines to FCTCPAC using the Logicon Data Terminal Simulation System (DTSS).

5.3.2 SMCM

The objective of the SMCM C⁴I system architecture for KB 95 was to allow the MCM ships operating in the Gulf of Mexico (GOMEX) OPAREA, USS *Dextrous* (MCM 13) and USS *Scout* (MCM 08), to operate effectively with the MCM forces operating in the SOCAL OPAREA. This

Table 5. KBITS transmission data rates.

Site	Bandwidth Allotted (Packets per Second)	Typical Number of Entities Transmitted	Typical Transmissions, where one burst represents about 0.5 second
1. NUWC, Newport	23	40 and 4 to 8	One burst of 35 to 40 packets every 5 seconds for 40 entities, and One burst of 2 to 7 packets every 5 seconds for 4 to 8 entities
2. BFTT/FCTCLAN, Dam Neck	23	10	Two bursts of 10 packets each, every 4 seconds
3. TACDEW / FCTCPAC, San Diego	43	34 and 7	One burst of 30 packets every second for 30 entities, and One burst of 9 packets every 2 seconds for 7 entities
4. NAWC, Pax River	12	3	One burst of 2 packets every 7 seconds
5. WISSARD, NAS Oceana	35	15	One burst of 35 packets every 7 seconds

required an accurate two-way exchange of information between live forces hundreds of miles apart, integrating them into a single force operating in the SOCAL OPAREA.

A Tactical Decision Aid (TDA) called Mine Warfare Environmental Decision Aids Library (MEDAL) was installed on the Joint Maritime Command Information System (JMCIS) at Commander Mine Warfare Command (CMWC), Ingleside, TX, and *Dextrous* and *Scout*. MEDAL provided mine positions through use of a formatted Operational Note (OPNOTE).

A Cell Adapter Unit (CAU) was responsible for geo-translation of the mine picture from the GOMEX area to the SOCAL area, as well as from the SOCAL area to the GOMEX area. Both pictures were provided bidirectionally to the Mine Warfare Commander (MWC) embarked on USS *Tripoli* (LPH 10), also running MEDAL, and to *Dextrous* and *Scout*. This was accomplished through use of the Continental U.S. (CONUS) OTCIXS net, where the MCM ships operated, and was sent to FCTCPAC for further transmission on PAC OTCIXS, where the MWC operated.

Dextrous was equipped with an OTCIXS suite. Additionally, *Scout* and *Dextrous* and CMWC were provided with a Line of Sight Information Exchange System (LOSIXS). *Dextrous* forwarded the MEDAL OPNOTES from MWC, and the FOTC broadcast from USS *Peleliu* (LHA 5) to *Scout* via LOSIXS.

5.4 DSI

The DSI network proved to be very reliable during KB 95. During KB 95, DSI was available for 58.41 of the needed 59.83 hours, or 97.62 percent. Adding in all testing, DSI was available for 117.48 of the scheduled 125.33 hours, or 93.74 percent. Normal DSI manning was used: one project manager and one lead technician. Other resources were called on as necessary.

There were two DSI outages during KB 95. The first was caused by a faulty disk for the Improved Network Encryption System (INES) at APL. This resulted in APL coming online 45 minutes late. Since APL was a Viewport, this did not impact the exercise. The second outage occurred in the last hours of the exercise, delaying the running of a test. A router that was not part of the KB 95 network was rebooted to support another exercise. The reboot caused a table problem with the routers that were supporting KB 95. All of the KB 95 routers had to be rebooted and the streams reconnected, resulting in 40 minutes of downtime for all sites.

5.5 SITE COMMENTS

At the conclusion of KB 95, all sites were invited to provide inputs and/or lessons learned to NRaD. The following responses were received:

WISSARD: Operations went really well. Air SAF did 100% of tasked evolutions using three personnel (two operators and one SW person) at FCTCPAC, and two personnel (one operator and one software person at WISSARD). One big lesson learned, which also came out of STOW-E, is the need to have a near-real-time network analysis capability available for FVs, SSITs, and the exercise itself. Also, it does not do any good to hold dress rehearsals unless all players participate. Some personnel did not take part in any testing, but did participate in KB 95 itself. Therefore, the first day was spent getting them up to speed. The first day was ragged, the second day was acceptable, the third and fourth days were where we needed to be.

APL: The Johns Hopkins University Applied Physics Laboratory (JHU/APL) implemented the Eastcoast VIP Viewport for the KB 95 exercise in the Warfare Analysis Laboratory. To show current exercise action during VIP viewing sessions, several large screen displays presented the tactical scene as created using JMCIS, and simulation ground truth using both a 2D plan view display and a 3D visualization display. JMCIS received real-time tactical information from the exercise over OTCIXS and Link-11 data links. Additionally, JMCIS was augmented with the capability to receive and display ground truth data of the simulated exercise platforms. Three VIP viewing sessions, each 2 hours long, were conducted each day. Three briefings were given during each session: an overview of the KB 95 exercise, a detailed briefing of the simulation aspects of KB 95, and an overview of the APL viewport displays and connectivity into the KB 95 exercise. A general question and answer session was interspersed with attention to ongoing action of the exercise. Playback of recorded events provided opportunities to observe other significant events of interest. The Viewport hosted over 250 VIPs and guests, including six flag officers, during the 4 viewing days.

In terms of lessons learned, below is a list of comments from the APL Viewport vantage point.

1. New entity enumerations were still being used during KB 95. During the exercise, missile types that were not defined in the KB 95 entity enumeration list were used by aircraft.
2. Fire PDUs did not contain the full set of information. Some Fire PDUs were properly filled out, allowing proper tracking of munitions using stealth viewers. However, some PDUs did not have all fields properly filled in, which prevented immediate tracking of launched munitions.
3. There needs to be a “viewport comms channel” during this type of exercise. To properly monitor engagements with 3D viewers, a viewport needs to know who is attacking who, and when. This prevents us from having to identify evolving engagements and guess as to who is the target of a given attack. Having a circuit where we could get this information would aid in our presentation.
4. Data logging did not seem to be a problem. We collected 3 GBytes for simulation data (including digital radio) and approximately 10 Mbytes for OTCIXS and Link-11 during the entire exercise.
5. The GPS time server was an excellent idea that worked very well.
6. The Plan View Display (PVD) and JMCIS displays of the entity state PDU information coming over the DSI provided an effective global tactical view.
7. VR-Link Stealth worked well for displaying one-on-one or many-on-one types of engagements. However, it is not capable of displaying a more global view or of giving a good view of many-on-many types of engagements.
8. Coordination of the 2-D and 3-D views was a labor-intensive activity. The VR-Link Stealth program can be controlled via Stealth Control PDUs. For future exercises, it may be worthwhile to modify the PVD code to emit these Stealth Control PDUs. With this modification, hooking an entity in the 2-D view will automatically hook the same entity in the 3-D VR-Link Stealth view.
9. Many times during the exercise there were engagements that were hard to watch because we did not know entity numbers for the platforms that were involved in the engagements. If we were told, for example, that hostile aircraft with triplets X,Y,Z were going to attack friendly ship with triplet Q, where triplets are (host, site, entity number), it would have been much

easier to set up to view the engagements. Many times during the exercise we had to guess at who the players in a particular engagement were, and this sometimes caused us to miss interesting action.

APPENDIX A

ACRONYMS

AAW	Anti-Air Warfare
ALSP	Aggregate Level Simulation Protocol
ATF	Amphibious Task Force
APL	Applied Physics Laboratory
ARG	Amphibious Ready Group
ARPA	Advanced Research Projects Agency
ATF	Amphibious Task Force
AWACS	Airborne Warning And Control System
BFTT	Battle Force Tactical Trainer
C ⁴ I	Command, Control, Communications, Computers, and Intelligence
C&R	Command and Reporting (sometimes called control and reporting)
CA	California
CAU	Cell Adaptor Unit
CG	Commanding General
CINCPACFLT	Commander in Chief, Pacific Fleet
COMCRUDESGRU	Commander, Cruiser Destroyer Group
COMPHIBGRU	Commander, Amphibious Group
COMTHIRDFLT	Commander, Third Fleet
CONUS	Continental U.S.
COTS	Commercial Off-the-Shelf
CP6-3	Amphibious Group Three
CTTM	Combined Team Trainer Mode
CV	Aircraft Carrier
CVBG	Aircraft Carrier Battle Group
CVN	Aircraft Carrier (Nuclear)
CWC	Composite Warfare Coordinator (Combined Warfare Coordinator)
DIS	Distributed Interactive Simulation
DMSO	Defense Modeling and Simulation Offers
DSI	Defense Simulation Internet
DSI Net	DSI Network
DTSS	Data Terminal Simulation System
ENWGS	Enhanced Navy Wargaming System
EOD	Explosive Ordnance Disposal
FCTCPAC	Fleet Combat Training Center, Pacific
FCTCLANT	Fleet Combat Training Center, Atlantic
FV	Functional Validation
FVT	Functional Validation Testing
FWD	Forward
GOMEX	Gulf of Mexico
GMT	Greenwich Mean Time
GPS	Global Positioning System

INES	Improved Network Encryption System
JMCIS	Joint Maritime Command Information System
KB 95	Kernel Blitz '95
KBITS	Kernel Blitz Interactive Training Support
MCM	Mine Counter Measure
MEDAL	Mine Warfare Environmental Decision Aids Library
MEF	Marine Expeditionary Force
MEU	Marine Expeditionary Unit
MIW	Mine In-Shore Warfare
MOA	Memorandum of Agreement
Mod TACDEW	Modified Tactical Advanced Combat Direction and Electronic Warfare
ModSAF	Modulated Semi-Automated Force
MUTTS	Multiple Unit Tactical Training System
MUX	Multiplex/Multiplexer
NAVSEA	Naval Sea Systems Command
NAWC-AD	Naval Air Warfare Center – Aircraft Division
NCCOSC	Naval Command, Control and Ocean Surveillance Center
NDC	Naval Doctrine Command
NETVIS	Network Visualization
NRaD	NCCOSC RDT&E Division
NSW	Naval Surface Warfare
NUWC	Naval Undersea Warfare Center
OPAREA	Operational Area
OPFOR	Opposition Forces
OPNAV	Office of the Chief of Naval Operations
OTC	Officer in Tactical Command
OTCIXS	Officer in Tactical Command Information Exchange System
PAX	Patuxent River
PDU	Protocol Data Unit
PEO	Program Engineering Office
PHIBLEX	Amphibious Exercise
POC	Point of Contact
PTT	Push-to-Talk
RDT&E	Research, Development, Test and Evaluation
SOC	Ship's Operational Capability
SOEs	Schedule of Events
SPAWAR	Space and Naval Warfare Systems Command
SSIT	Subsystem Integration Test
SSN	Submarine (Nuclear)
STOW-E	Synthetic Theater of War – Europe
SUBTRAFAC	Submarine Training Facility
SWEG	Simulated Warfare Environment Generator

TACDEW Tactical Advanced Combat Direction and Electronic Warfare
TBD To be Determined

UHF Ultra-High Frequency
USMC United States Marine Corps

WISSARD What If Simulation System for Advanced Research and Development

**APPENDIX B
KBITS DIS 2.0.3+**

Entity	DIS Enumeration Version 2.0.3+	BFTT 2.0.3+ at FCTCPAC & FCTCL ANT	TACDEW Block 0 at FCTCPAC	NUWC at Newport, RI			ModSAF at FCTCPAC, WISSARD, and NAWC-AD, PAX R.
US SHIPS	(Note: Double Borders indicate additions to 2.0.3)			GSS #	21B64 Supported	STVTS Supported	
CVN 68, Class							
CVN 70, CARL VINSON	1.3.225.1.1.3	CVN-70	(80) CV	120	Yes	Yes	CVN
AAGF Command Ship Class							
AGF 11, CORONADO (C3F)	Real Ship (Updated by Link 11 only)		(99) AUXILIARY				
CG 47 Class							
CG 49 VINCENNES	1.3.225.3.1.3	CG-49	(90) CG	117	Yes	Yes	CG-47
CGN 41 ARKANSAS	1.3.225.3.2.4	CGN-41	(85) CGN	117	Yes	Yes	CGN-41
DDG 51 Class							
DDG 54, CURTIS WILBUR	Real Ship (Updated by Link 11 only)		(88) DDG				
DD 963 Class							
DD 964, PAUL F. FOSTER	1.3.225.5.1.2	DD-964	(91) DD	112	Yes	Yes	Generic Ship
DD 973, JOHN YOUNG	Real Ship (Updated by Link 11 only)		(91) DD				
DD 986, HARRY W. HILL	1.3.225.5.1.24	DD-986	(91) DD	112	Yes	Yes	Generic Ship
FFG 7 Class							
FFG 30, REID	1.3.225.6.1.22 (Also Real Ship, used for OPFOR)	FFG-30	(83) FFG	114	Yes	Yes	FFG-7
FFG-51, GARY	Real Ship (Updated by Link 11 only)		(83) FFG				FFG-7

Entity	DIS Enumeration Version 2.0.3+	BFTT 2.0.3+ at FCTCPAC & FCTCL ANT	TACDEW Block 0 at FCTCPAC	NUWC at Newport, RI			ModSAF at FCTCPAC, WISSARD, and NAWC-AD, PAX R.
US SHIPS (cont.)	(Note: Double Borders indicate additions to 2.0.3)			GSS #	21B64 Supported	STVTS Supported	
LSD							
LSD-36, ANCHORAGE	Real Ship (Updated by Link 11 only)		(94) LPD				
LSD-45, COMSTOCK	Real Ship (Updated by Link 11 only)		(94) LPD				
LSD 39, MOUNT VERNON	Real Ship (Updated by Link 11 only)		(94) LPD				
LST							
LST 1184, FREDERICK	Real Ship (Updated by Link 11 only)		(98) LST				
MCM 1 Class							
MCM 1, AVENGER	Real Ship (Updated by Link 11 only)		(101) MSO				
MCM 8, SCOUT	Real Ship (Updated by Link 11 only)		(101) MSO				
MCM 13, DEXTEROUS (W/JOTS)	Real Ship (Updated by Link 11 only)		(101) MSO				
PC 7 , SQUALL	1.3.225.7.1.7 (Also REAL ship)	PC-7	(134) PC	131	No	No	Generic Ship
PC 8 , ZEPHYR	1.3.225.7.1.8 (Also REAL ship)	PC-8	(134) PC	131	No	No	Generic Ship
MSO 427 Class							
MSO 427, CONSTANT	Real Ship (Updated by Link 11 only)		(101) MSO				
AO 177 Class, Fleet Oiler							
AO 177, CIMARRON	1.3.225.16.1.1 Also a REAL Ship (Updated by Link 11)		(99) AUXILIARY				
AOR-7, ROANOKE	1.3.225.16.8.7 Also a REAL Ship (Updated by Link 11)		(99) AUXILIARY				

Entity	DIS Enumeration Version 2.0.3+	BFTT 2.0.3+ at FCTCPAC & FCTCL ANT	TACDEW Block 0 at FCTCPAC	NUWC at Newport, RI			ModSAF at FCTCPAC, WISSARD, and NAWC-AD, PAX R.
US SHIPS (cont.)	(Note: Double Borders indicate additions to 2.0.3)			GSS #	21B64 Supported	STVTS Supported	
Aux., Merchant Marine							
USNS, TATF 169, NAVAJO	1.3.225.17.7.4 (Also Real ship)	TATF-169	(99) AUXILIARY	(none)	No	No	Generic Ship
USNS TAVB 4, CURTIS	1.3.225.17.15.2 (Also Real ship)	TAVB-4	(99) AUXILIARY	125	Yes	Yes	Generic Ship
USNS, TAH 19, MERCY	1.3.225.17.16.1 (Also Real Ship))	TAH-19	(99) AUXILIARY	127	Yes	Yes	Generic Ship
LHA Class							
LHA 1, TARAWA	Real Ship (Updated by Link 11 only)		(81) LHA				
LHA 5, PELELIU	Real Ship (Updated by Link 11 only)		(81) LHA				
LPH Class							
LPH 10, TRIPOLI	Real Ship (Updated by Link 11 only)		(93) LPH				
LPH 11, NEW ORLEANS	Real Ship (Updated by Link 11 only)		(93) LPH				
LKA 113 Class							
LKA 113, CHARLESTON	Real Ship (Updated by Link 11 only)		(94) LPD				
LPD Class							
LPD 4, AUSTIN	Real Ship (Updated by Link 11 only)		(94) LPD				
LPD 6, DULUTH,	Real Ship (Updated by Link 11 only)		(94) LPD				
LPD 10, JUNEAU,	Real Ship (Updated by Link 11 only)		(94) LPD				
Non-Combatant							
USCGC HAMILTON	Real Ship (Updated by Link 11 only)		(96) FF				

Entity	DIS Enumeration Version 2.0.3+	BFTT 2.0.3+ at FCTCPAC & FCTCL ANT	TACDEW Block 0 at FCTCPAC	NUWC at Newport, RI			ModSAF at FCTCPAC, WISSARD, and NAWC-AD, PAX R.
OPFOR SHIPS	(Note: Double Borders indicate additions to 2.0.3)			GSS #	21B64 Supported	STVTS Supported	
Combatant							
(DD 972 OLDENDORF) REAL SHIP	Real Ship (Updated by Link 11 only.)		(91) DD = KRESTA II				
(FFG 30, REID) REAL SHIP	Real Ship (Updated by Link 11 only. Also used as Sim. US ship)		(83) FFG = SLAVA				
La COMBATTANTE	1.3.222.7.13.0	PC	(134) PC	81	Yes	Yes	PC
NANUCHKA III	1.3.222.13.4.0	NANUCHKA III	(128) NANUCHKA	85	Yes	Yes	PC
Osa II	1.3.222.7.4.0	OSA II	(135) OSA I/II	80	Yes	Yes	Generic Ship
PHM Class							
PHM 1, PEGASUS (Sinhung, PCH)	1.3.225 .7.1.1	PHM-1	(133) PHM	(none)	No	No	Generic Ship
FFL							
Koni	1.3.222.50.9.0	Koni	(135) OSA 1/II	80	Yes	Yes	Generic Ship
Mine Layer							
USCGC Tybee	Real Ship (Updated by Link 11 only)		(96) FF				
Mine CC Craft (ALESHA Class)	1.3.222.8.1.0	ALESHA Class	(101) MSO				
Merchant Ships							
MERCHANT, CARGO, AMERICAN KENTUCKY	1.3.225 .61.1.1	SS AMERICAN KENTUCKY	(99) AUXILIARY	123	Yes	Yes	Generic Ship
MERCHANT, TANKER, TEXACO, GEORGIA	1.3.225 .61.2.1	SS TEXACO, GEORGIA	(99) AUXILIARY	125	Yes	Yes	Generic Ship
Fishing Craft	1.3.225 .61.30.1	Fishing Craft	(115) AGI	(none)	No	No	Generic Ship

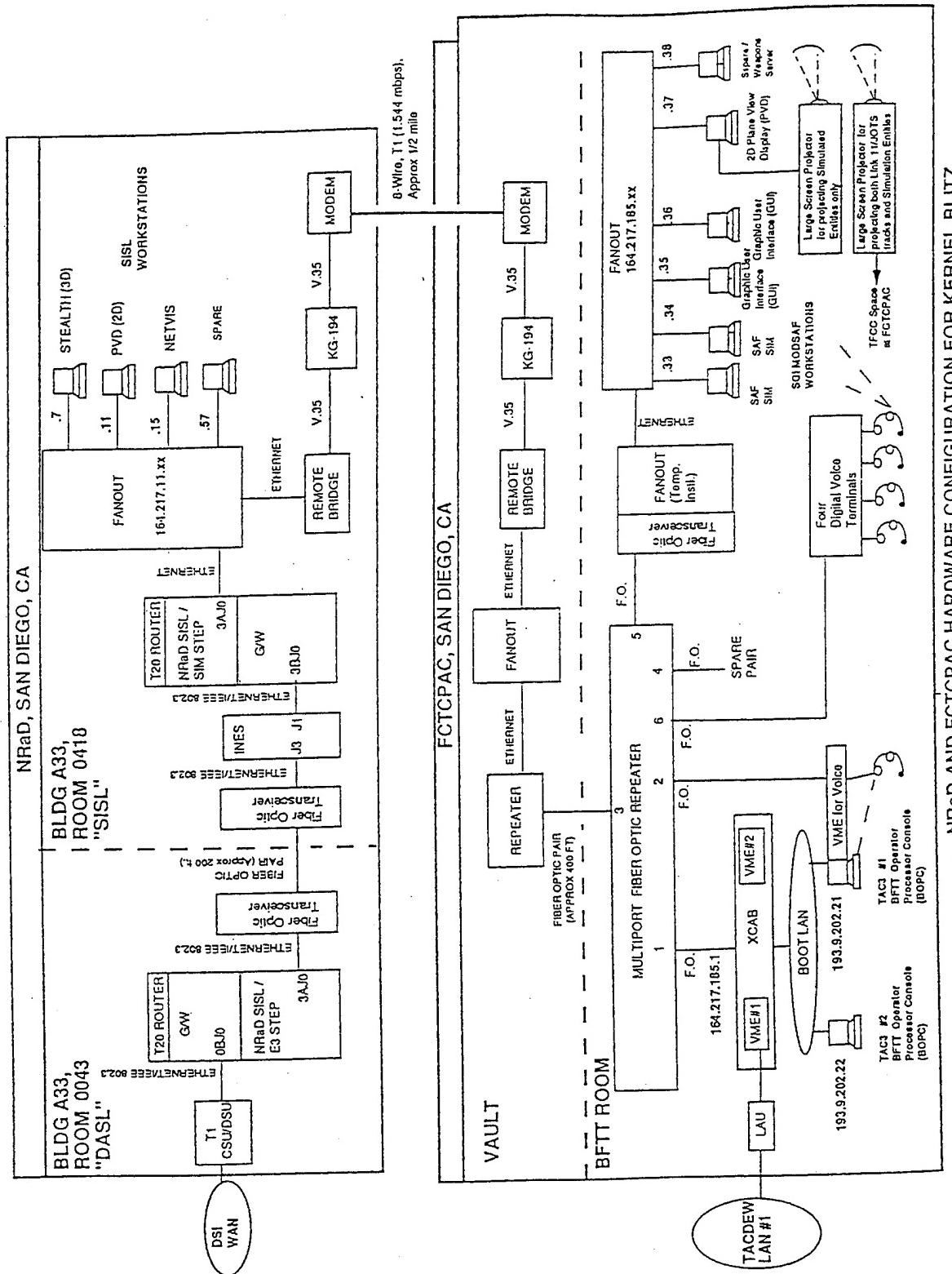
Entity	DIS Enumeration Version 2.0.3+	BFTT 2.0.3+ at FCTCPAC & FCTCL ANT	TACDEW Block 0 at FCTCPAC	NUWC at Newport, RI			ModSAF at FCTCPAC, WISSARD, and NAWC-AD, PAX R.
OPFOR AIR	(Note: Double Borders indicate additions to 2.0.3)			GSS #	21B64 Supported	STVTS Supported	
Fighter/Air Defense							
MIG-29, Fulcrum A	1.2.222.1.2.0	MIG-29	(9) MIG-29	(none)	No	No	MIG-29
MiG-23, FLOGGER	1.2.222.1.5.0	MIG-23	(14) MIG-23	(none)	No	No	MIG-23
MiG-21, FISHBED	1.2.222.1.6.0	MIG-21	(17) MIG-21	(none)	No	No	MIG-21
Attack/Strike							
SU-25	1.2.222.2.8.0	SU-25	(4) SU-17	(none)	No	No	SU-25
SU-15	1.2.222.1.10.0	SU-15	(6) SU-15	(none)	No	No	SU-15
Fighter/Strike (Type 1)							
MIG-15	1.2.222.1.10.0	(none)	(none)	(none)	No	No	MIG-15
MIG-17	1.2.222.1.8.0	MIG-17	(17) MIG-21	(none)	No	No	MIG-17
MIG-19	1.2.222.1.7.0	MIG-19	(17) MIG-21	(none)	No	No	MIG-19
Cargo/Tanker							
IL-76 CANDID	1.2.222.4.3.0	IL-76	(32) 707	(none)	No	No	(TBD)
IL-76 MAINSTAY	1.2.222.4.3.1	IL-76.1	(32) 707	(none)	No	No	(TBD)
Bomber - ASW							
Beagle (IL-28)	1.2.222.5.2.1	(none)	(none)				
Helo							
MI-4 HOUND	1.2.222.7.6.0	(none)	(none)				
MI-8 HIND	1.2.222.7.1.10	(none)	(none)				
H500 Hughes Helo	1.2.222.20.2.12	(none)	(none)				

Entity	DIS Enumeration Version 2.0.3+	BFTT 2.0.3+ at FCTCPAC & FCTCL ANT	TACDEW Block 0 at FCTCPAC	NUWC at Newport, RI			ModSAF at FCTCPAC, WISSARD, and NAWC-AD, PAX R.
OPFOR WEAPONS	(Note: Double Borders indicate additions to 2.0.3)			GSS #	21B64 Supported	STVTS Supported	
Surface-Air							
SA-2 SAM	2.1.222.1.13.0	SA-2	(58) SAM	(none)	No	No	(TBD)
SA-3A SAM	2.1.222.1.14.0	SA-3A	(58) SAM	(none)	No	No	(TBD)
SA-5 SAM	2.1.222.1.16.0	SA-5	(58) SAM	(none)	No	No	(TBD)
Anti-Ship							
406 mm Torpedo	2.6.222.1.18.0	406 mm Torpedo	(110) TORPEDO	144	Yes	No	(TBD)
533 mm Torpedo, (E53 72A)	2.6.222.1.17.0	533 mm Torpedo	(110) TORPEDO	146	Yes	No	(TBD)
SS-N-2C, STYX	2.6.222.1.8.1	SS-N-2C	(57) SSM	(none)	No	No	(TBD)
SCUD Missile (SS-4)	2.9.222.1.13.0	SS-4	(57) SSM	(none)	No	No	(TBD)
Mines							
V1 Mine	2.6.222.3.7.0	V1 Mine	(none)	134	No	No	(TBD)
Air to Air Missiles							
AA-10, ALAMO	2.1.222.1.10.0	AA-10					
AA-11, ARCHER	2.1.222.1.11.0	AA-11					
AA-12,	2.1.222.1.12.0	AA-12					
Air to Ground Bombs							
30HE Ballistic Bomb	2.2.222.2.2.0	30 HE Bomb					
MK-82 Ballistic Bomb (Equivalent)	2.12.225.2.9.0	MK-82 Bomb					
Counter Measures							
UC-2S	11.4.222.1.0.0	UC-2S	(109) DECOY	135	No	No	(TBD)
UC-5M	11.4.222.2.0.0	UC-5M	(109) DECOY	136	No	No	(TBD)
BAT-1 (Towed)	11.4.222.3.0.0	BAT-1 (Towed)	(109) DECOY	155	No	No	(TBD)

Entity	DIS Enumeration Version 2.0.3+	BFTT 2.0.3+ at FCTCPAC & FCTCL ANT	TACDEW Block 0 at FCTCPAC	NUWC at Newport, RI			ModSAF at FCTCPAC, WISSARD, and NAWC-AD, PAX R.
US WEAPONS	<i>(Note: Double Borders indicate additions to 2.0.3)</i>			GSS #	21B64 Supported	STVTS Supported	
Torpedos							
Mk 67 SLMM	2.13.225.1.0.0	Mk-67	(none)	151	No	No	(TBD)
MK 46, Mod 0, Torpedo	2.7.225.1.1.0	Mk-46 Mod 0 Torpedo	(110) Torpedo	157	No	No	(TBD)
MK 48 torpedo	2.7.225.1.2.0	Mk-48 Torpedo	(110) Torpedo	153	Yes	No	(TBD)
ADCAP	2.7.225.1.10.0	ADCAP	(110) Torpedo	154	Yes	No	(TBD)
Surface to Surface Missiles							
ARM/RGM-84A, HARPOON	2.6.225.1.1.0	84-A	(71) HARPOON	3	Yes	Yes	(TBD)
ARM/RGM-84B, HARPOON	2.6.225.1.2.0	84-B	(71) HARPOON	3	Yes	Yes	(TBD)
ARM/RGM-84C, HARPOON	2.6.225.1.3.0	84-C	(71) HARPOON	3	Yes	Yes	(TBD)
ARM/RGM-84D, HARPOON	2.6.225.1.4.0	84-D	(71) HARPOON	3	Yes	Yes	(TBD)
BGM-109C, TOMAHAWK	2.9.225.1.6.0	BGM-109C	(70) TOMAHAWK	5	Yes	Yes	(TBD)
Air to Air Missiles							
AIM-7, SEA SPARROW	2.1.225.1.12.0	AIM-7					
AIM-9, SIDEWINDER	2.1.225.1.1.0	AIM-9					
AIM-54, PHOENIX	2.1.115.1.8.0	AIM-54					
Air to Ground Bombs							
Mk 82, Ballistic Bomb	2.12.225.2.9.0	Mk 82					
Mk 84, Ballistic Bomb	2.12.225.2.11.0	Mk 84					
Counter Measurs							
CM NAE	11.4.225.1.0.0	CM NAE	(109) DECOY	139	No	No	(none)
CM ADCT	11.4.225.2.0.0	CM ADCT	(109) DECOY	140	No	No	(none)
CM ADCS	11.4.225.3.0.0	CM ADCS	(109) DECOY	141	No	No	(none)
CM ADCN	11.4.225.4.0.0	CM ADCN	(109) DECOY	142	No	No	(none)

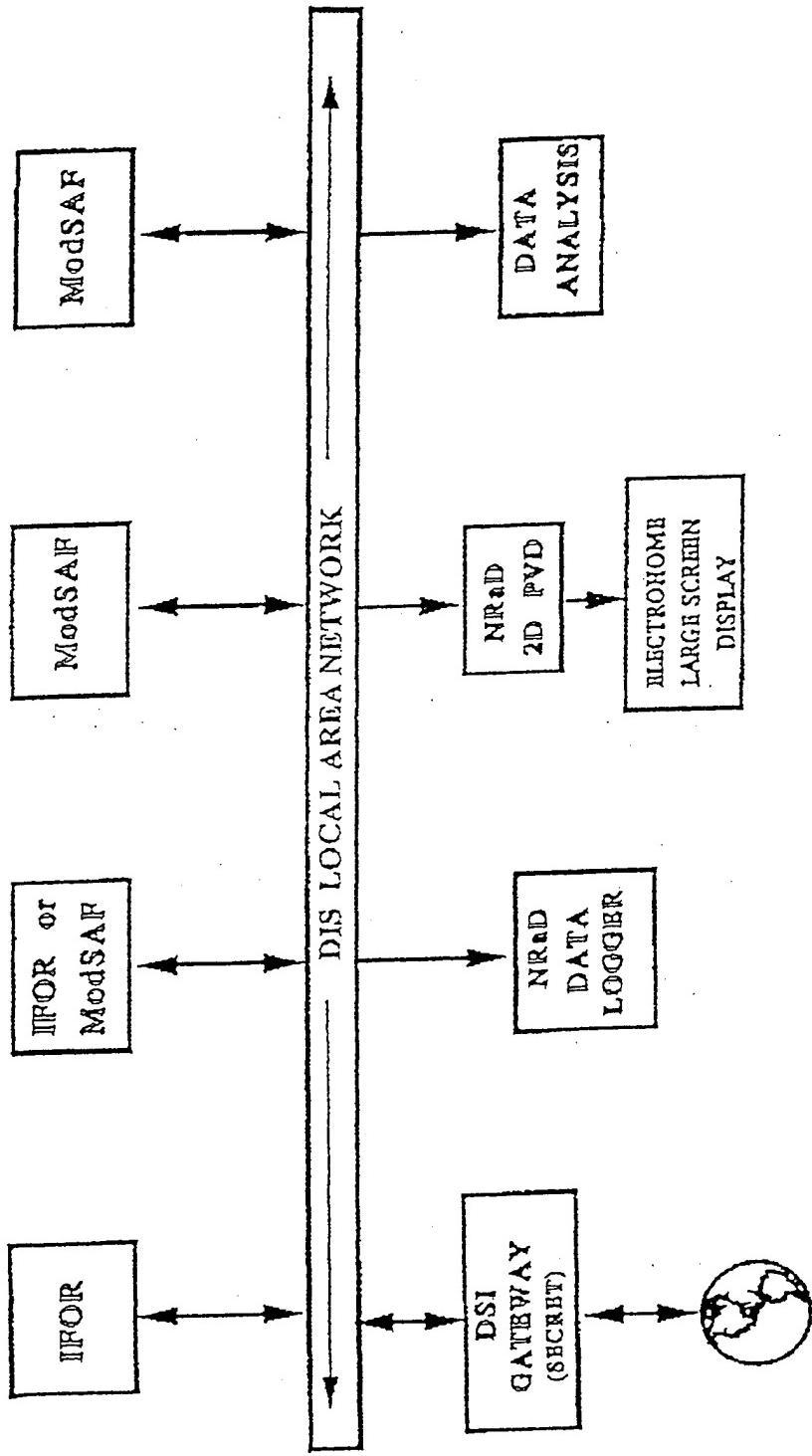
Entity	DIS Enumeration Version 2.0.3+	BFTT 2.0.3+ at FCTCPAC & FCTCL ANT	TACDEW Block 0 at FCTCPAC	NUWC at Newport, RI			ModSAF at FCTCPAC, WISSARD, and NAWC-AD, PAX R.
US WEAPONS	(Note: Double Borders Indicate additions to 2.0.3)			GSS #	21B64 Supported	STVTS Supported	
US SONOBUOY							
SSQ-90	8.3.225.19.1.1	SSQ-90	(none)	(none)	No	No	(TBD)

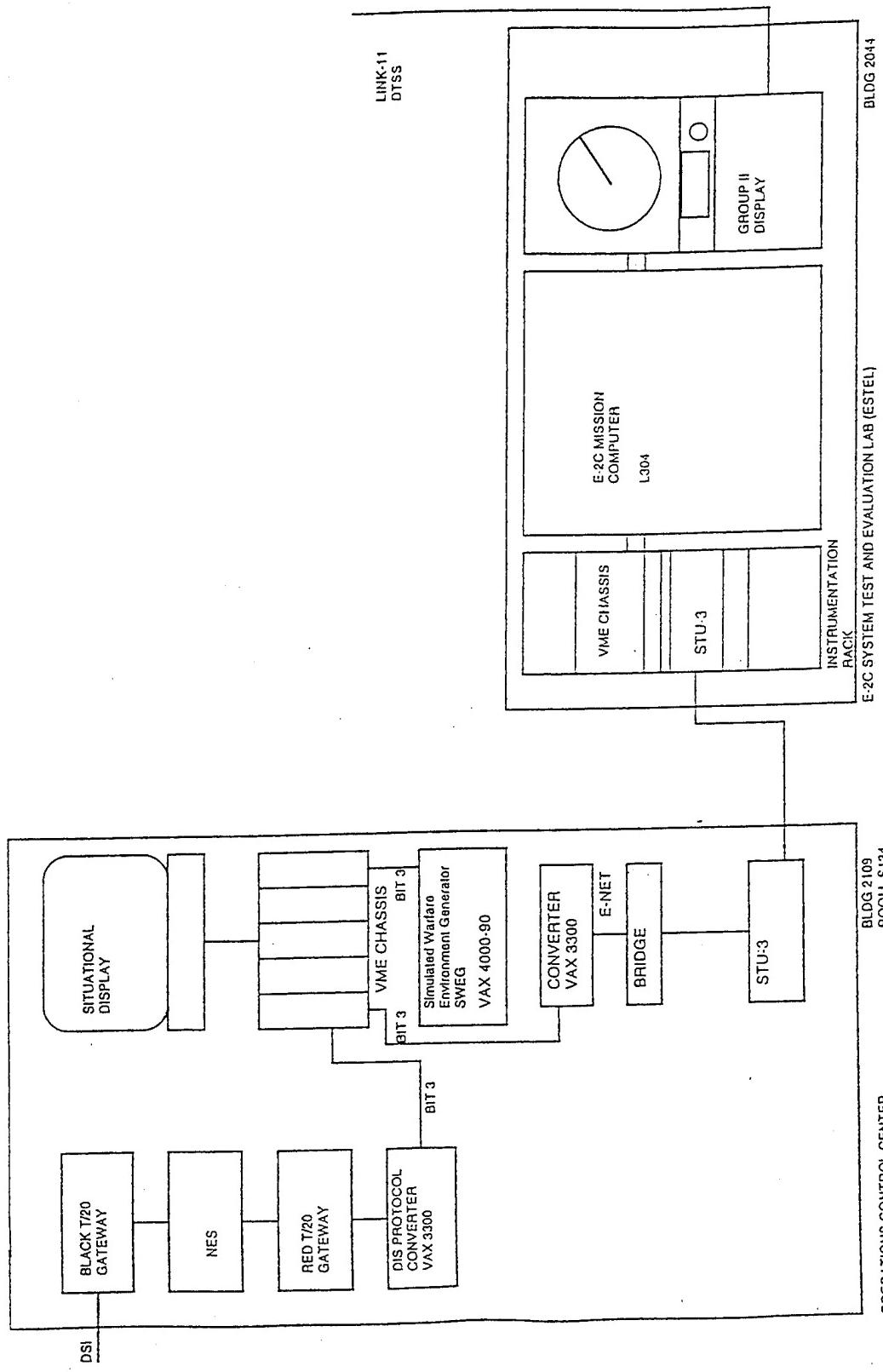
APPENDIX C
KBITS SITE TOPOLOGIES

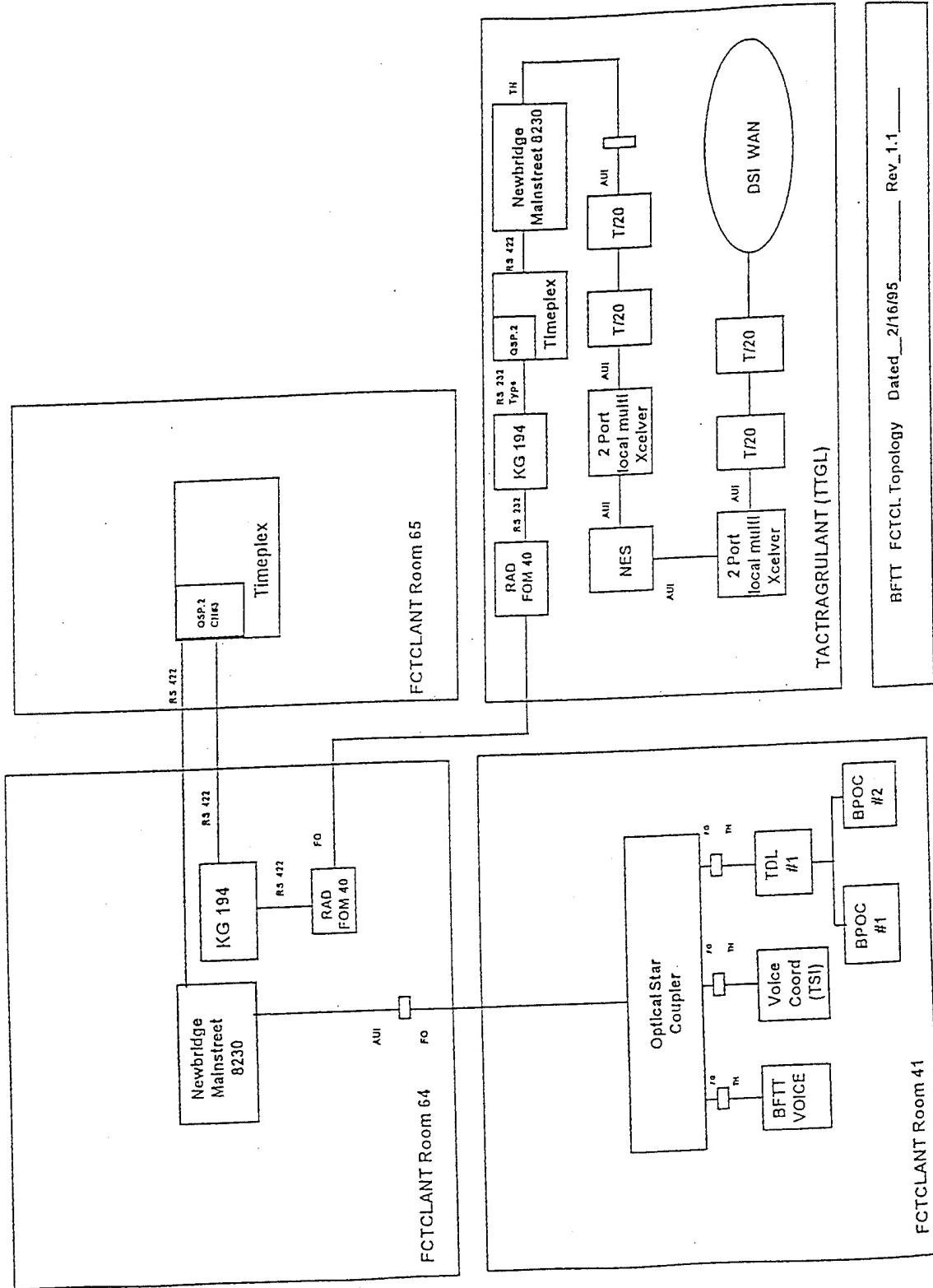


WISSARD "Kernel Blitz-95"

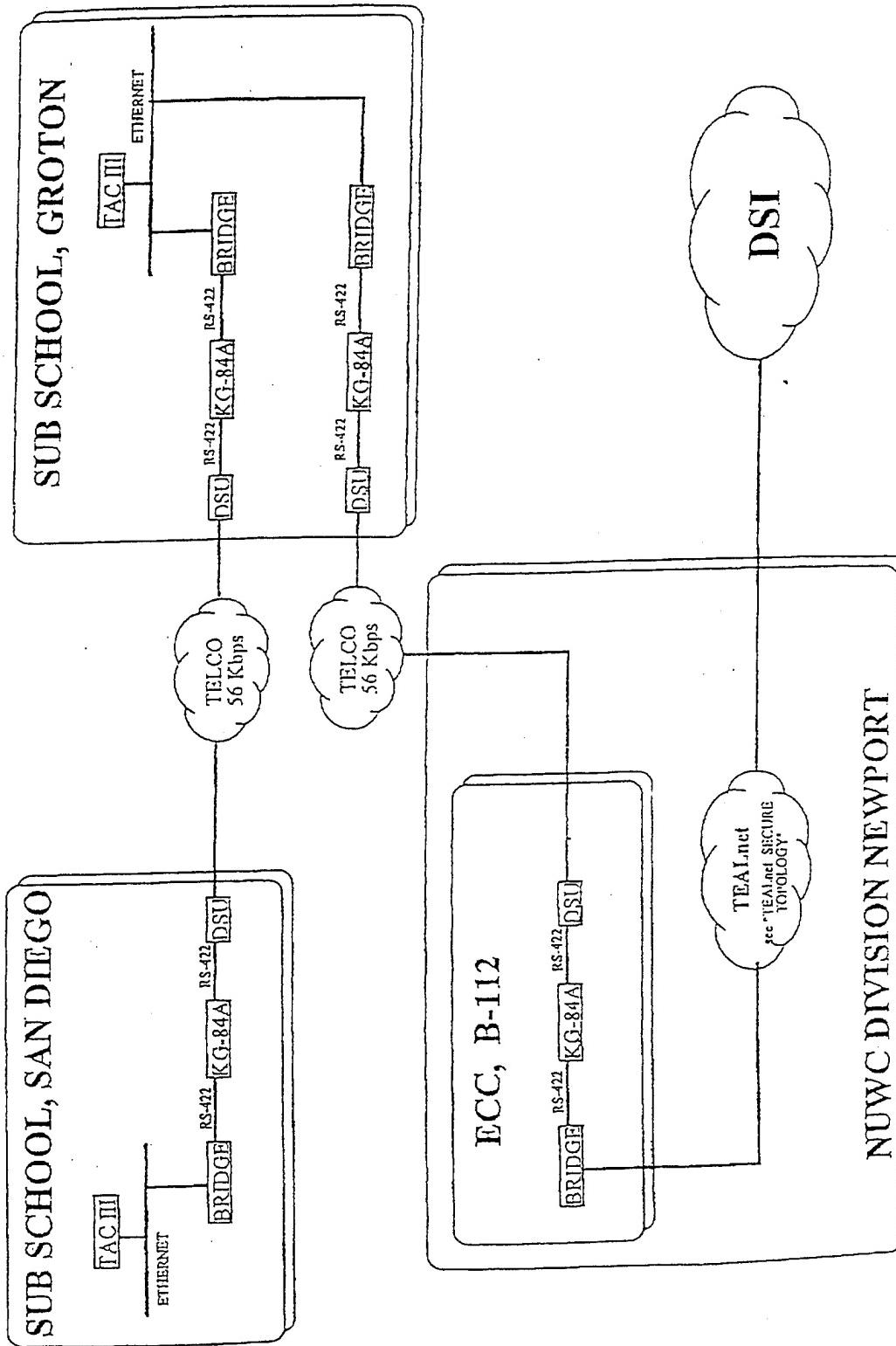
(TOPOLOGY OF WISSARD EQUIPMENT TO BE USED IN SUPPORT
OF KERNEL BLITZ-95 ACTIVITIES)



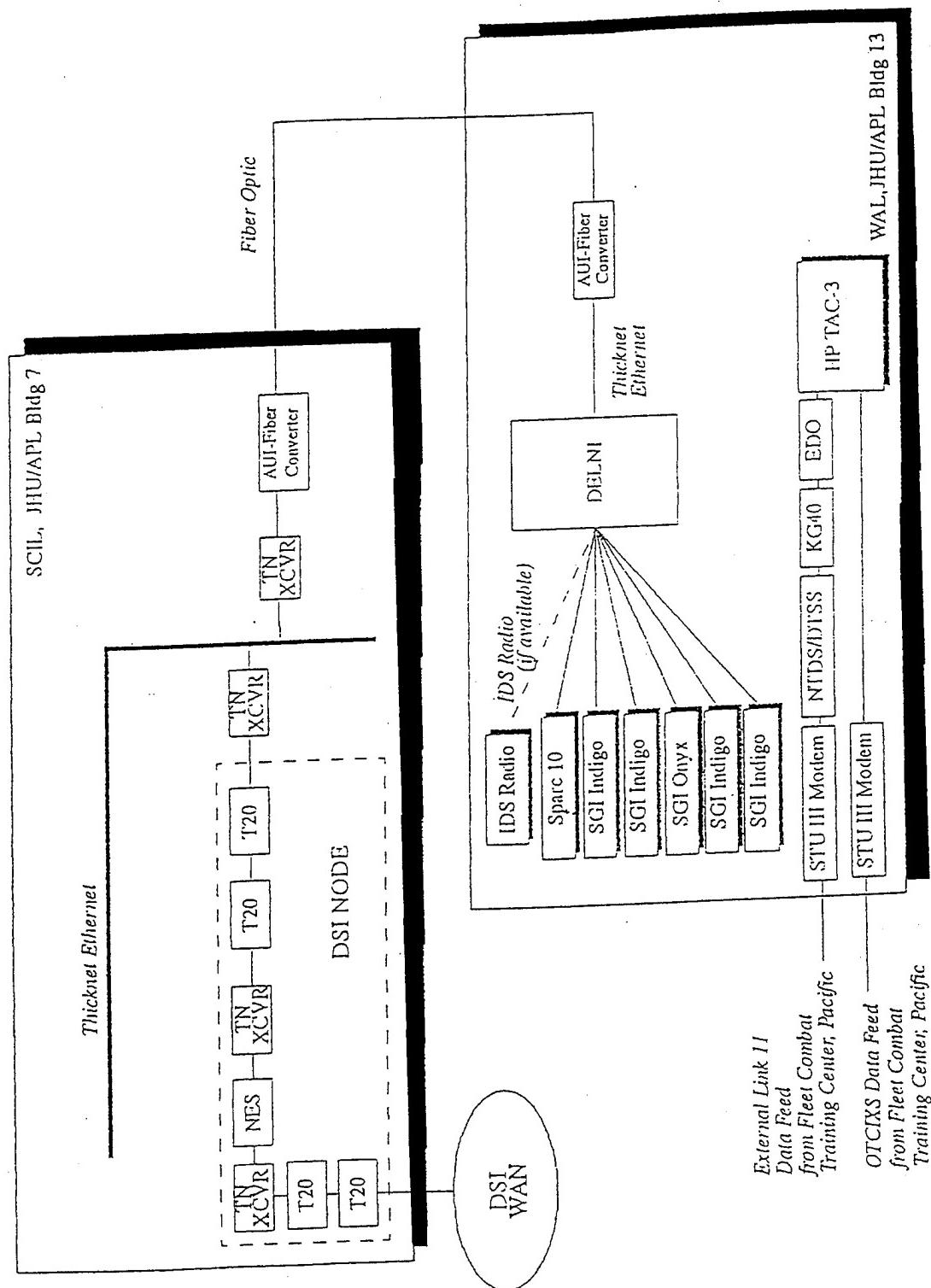




TEALnet TOPOLOGY FOR KERNEL BLITZ



JHU/APL Conceptual Communication Topology (Rev 2)



REPORT DOCUMENTATION PAGE

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